COMPLIANCE FOR LIFESTYLE MODIFICATION AMONG OBESE/OVERWEIGHT SCHOOL CHILDREN FROM 7 - 12 YEARS

Dissertation submitted to

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M.D DEGREE (PEDIATRICS) BRANCH VII

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CERTIFICATE

This is to certify that the dissertation titled, **"Compliance for lifestyle modifications among obese/overweight school children from 7 – 12 years"** submitted by **Dr. Preethi. K,** to the Faculty of Pediatrics, The Tamilnadu Dr.M.G.R Medical University, Chennai, in partial fulfillment of the requirements for the award of M.D. Degree (Pediatrics) is a bonafide research work carried out by him under our direct supervision and guidance, during the academic year 2009-2011.

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The Institutional Review Board [Ethical committee] of Institute of Child Health and Hospital for Children, Chennai-08, was held on 30.01.2010 at 10.00AM at the Deputy Superintendents chamber.

Members Present: Dr.R.Kulandai Kasthuri
Chair Person.

Members:
1. Dr.K.Gita
2. Dr.P.Jeyachandran
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Title: " Compliance for Life Style modifications among Obese / Overweight School Children from 7-12 years".

The Institutional Review Board was satisfied with the revised format submitted by you. Hence the Institutional Review Board is pleased to approve the study.

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To,
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INTRODUCTION

Obesity has emerged as a global epidemic in children. Both in developed and as well as developing countries, the last few decades have seen momentous increase in the prevalence of obesity and overweight among children and adolescent [1,2]. Most of the developing countries are in a phase of nutrition transition. The transition in nutrition and lifestyle, e.g. popularity of fast foods, soft drinks, sedentary lifestyle and lack of exercise, increased television watching and computer use are the common trends adopted by children today. The nutrition transition is associated with a change in dietary habits, decreasing physical activity and rising prevalence of obesity [3].The obesity and overweight rates were found to have tripled among adolescents (from 5% to 17%), increased four times among children aged 6–11 years (from 4% to 19%), and twofold among children aged 2–5 years (from 5% to 14%) in America over the last four decades. [4]

The 21st century epidemiological transition is manifesting in the form of shift towards increase in prevalence of non communicable diseases (NCD's) and a decline in communicable diseases. There is established evidence that all NCD's are associated with overweight and obesity. At a time when various public health policies were targeted and implemented to prevent malnutrition and stunted growth among the

paediatric population of developing countries, today, overweight and obesity has also become a major public health concern especially in the urban areas in many developing countries, including India[5,6]. Increasing numbers of children worldwide are estimated to be overweight or obese; the International Obesity Task Force (IOTF) in 2003 reported that among children aged 5 to 17 years, 1 out of 10 children are overweight or obese[7]. WHO estimated that 43 million children under the age of 5 years will be overweight in 2010 (WHO, 2009). The prevalence of childhood obesity is reported to be in the range of 14 to 20% in industrialised countries (WHO, 2000) [8].

Definition of obesity

- The World Health Organization (WHO) defines obesity as the "abnormal or excessive accumulation of fat in adipose tissue to the extent that health may be impaired" (WHO, 2000)[8].
- Obesity is a state of excess adipose tissue mass [9].

Body weights are distributed continuously in population, so that a medically meaningful distinction between lean and obese is somewhat arbitrary. So, obesity is therefore more effectively defined by assessing its linkage to morbidity or mortality.

Body mass index (calculated as weight in kilograms divided by height in meters squared) is the preferred method for the recognising the overweight or obese children [10]. The BMI is a measure of excess weight in relation to their height rather than excess body fat and may be less sensitive indicator of fatness in children [11]. Other methods to measure obesity include skin- fold thickness, densitometry, computed tomography or magnetic resonance imaging and electrical impedance. Although various approaches are available to measure body fat, many are unfeasible for clinical use. Waist circumference is an important measure of adiposity, but no large scale percentiles data in Indian children is available at present. BMI was recognised as the standard practical measure of adiposity [12].An increased BMI is related to morbidity and mortality, even if there is no precise relation of BMI values to body fat content. Following the widespread use of BMI in adults, BMI is now accepted as the standard method in children [13].

Obesity is recognised in children using the age and gender specific charts for BMI released by the Centre for Disease Control (CDC) [14, 15].The CDC defines normal weight for height as a BMI between 5th percentile to 84th percentile. A BMI between the 85-95th percentile is called at risk for overweight and a BMI greater than the 95th percentile is called overweight [16, 17]. These terms overweight and obesity are used

interchangeably though obesity can also be referred to as a level of overweight that has accompanying adverse physical or psychological issues.

According to WHO [18], Overweight is defined as > +1 Standard deviation (equivalent to BMI 25 kg/m^2 at 19 years), while obesity is defined as > +2 Standard deviation (equivalent to BMI 30 kg/m^2 at 19 years) At present, IAP has suggested to use WHO growth charts, in which India was one of the participating countries in the generation of these charts**.**

International Obesity Task Force 2000 classified the children based on their body mass index as below [7]

< 5^{th} percentile for age and gender	Underweight
5^{th}-84^{th} percentile for age and gender	Healthy weight
85^{th}-94^{th} percentile for age and gender	Overweight
>/=95^{th} percentile for age and gender	Obesity

Pathogenesis

Substantial evidence suggests that body weight is regulated by both endocrine and neural components that ultimately influence the effector arms of energy intake and expenditure. This complex regulatory system is necessary because even small imbalances between the energy intake and expenditure will ultimately have large effects on body weight. Obesity results from a dysregulation of calorie intake and energy expenditure. A

complex interplay between each individual‘s genetic predispositions and the environment affects an intricate system that controls appetite and energy expenditure. The role of both genetics as well as the environment cannot be underestimated in the causation of obesity.

Role of genes

Obesity is seen commonly in families but the inheritance is not mendelian.These genetic effects seem to be both for the energy intake and its expenditure. There is a concept of body weight “set point” supported by the physiological mechanism centered on a sensing system in adipose tissue that reflects fat stores and a receptor, or “adipostat” in the hypothalamus. When fat stores are depleted, the adipostat signal is low, and the hypothalamus responds by stimulating hunger and decreasing energy expenditure to conserve energy and vice versa. The *ob* gene and its product leptin provide the molecular basis for this physiological phenomenon [(9)].

Gastrointestinal hormones like cholecystokinin, glucagon like peptide 1, peptide YY and vagal neuronal feedback promote satiety, whereas ghrelin stimulates appetite. Adipose tissue provides feedback regarding energy storage levels to the brain through hormonal release of leptin and adiponectin. These hormones act on the arcuate nucleus in the hypothalamus and on the solitary tract nucleus in the brainstem.

Neuropeptides in the brain like neuropeptide Y, agouti gene related peptide and orexin appear to be involved in appetite stimulation, whereas alpha-melanocortin stimulating hormone is involved in satiety. The neuroendocrine control of appetite and weight is in a negative feedback mechanism system, balanced between short term control of appetite (ghrelin, PYY) and long term control of adiposity (leptin) [17]. Obesity has an early onset, even in infancy from mutations in genes encoding adipose-tissue-secreted hormones (e.g. leptin), neuropeptides (e.g. pro-opiomelanocortin, cocaine- and amphetamine-regulated transcript protein , and melanocortin 4), or defects in the receptors for these substrates [19]. Even though these monogenetic causes of obesity are rare, a study done in Cambridge has shown that about 4% of children who are obese by first decade of their life have a defect in the melanocortin 4 receptor [20].

Role of environment

Though genes play an important role in the pathogenesis of obesity, the role of the environmental changes cannot be downgraded. In the presence of nutritional abundance and a sedentary lifestyle greatly influenced by the genetic endowment results in increased adipose energy stores and adverse health consequences. There has been a drastic change in lifestyle throughout the world in the past few decades that have resulted in decrease in the time spent on physical activity, increased

pursuits of sedentary activities and excess calorie intake. Children use vehicles for transportation even for walk able distances, including elevators rather than walking or climbing stairs. The time, the children spend on active physical labour has withered during the past few decades and physical education training in schools have dwindled to a greater extent [21]. Most of the families now have both parents working, which has resulted in lack of time to supervise their children after school. Fear of children being hurt while playing outside without their supervision has led many parents to avoid letting their children play outside. Most parents depend on schools to provide their children with adequate amount of physical exercise, but only 25% of students in schools actually participate in daily physical education training [22].

Children are now spending more time watching television and surfing internet and playing games on computers or mobile than playing games outdoor. Television watching has been directly related with obesity in children, with a rate of obesity being about 8.3-times higher in children who watch television for more than 5 hours per day compared with children who watch up to 2 hours of television per day [23]. The other means of screen time such as internet surfing, video games, mobile communication and games have decreased the physical activity of the children.

The concept of healthy home-made food has taken a backseat in these days of hectic lifestyle. Fast food is the order of the day, which have high calorie content, fat, simple sugar, sodium and are low in fibre content and micronutrients. Skipping breakfast is found to be a risk factor in many studies. Fast food is advertised to children using television, toys, music, newspaper and famous personalities. Studies have found that children's food liking can be influenced by exposure to television advertisement of just 30 seconds [24]. Snacking in between meals has raised steadily over the last few decades, with many snacks being high in fat, simple sugar. Of late there is increase in the intake of sweetened beverages among children, which has been linked with increased weight gain and high calorie intake.

Morbidity

Obesity is a challenging multifactorial disease. Obesity in childhood is an important risk factor for obesity in adulthood. And about 80% of them become obese. According to the World Health Organization (WHO) latest projections for the world in 2005 there were approximately 1.6 billion overweight adults (age 15+) and at least 400 million adults were obese. Worldwide, 20 million children under the age of 5 years are overweight. Most individuals develop their eating and activity patterns

during childhood [25]. This phenomenon of tracking has warranted early intervention in these children.

Excess body fat is associated with insulin resistance, impaired glucose tolerance, hypertension, atherosclerotic risk factors and type 2 diabetes among children and adolescents [26-29]. Persistence of overweight and obesity into adulthood leads to cardiovascular disease risk, type 2 diabetes, hyperlipidemia, hyperinsulinemia, arthritis, sleep disorders and behavioural problems and cancer[30,31].They are more prone to develop asthma, musculoskeletal disease, gallstones, polycystic ovary disease and non alcoholic liver disease. Obesity has also adverse physical, social, and economic consequences that can negatively affect quality of life (QOL).

Cardiovascular disease

The Bogalusa Heart Study observed that children with a BMI above the 85th percentile were more likely to have hypercholesterolemia, hypertriglyceridemia, or hypertension than other children. The metabolic syndrome (hypertension, glucose intolerance, hypertriglyceridemia, low high-density lipoprotein level, abdominal central obesity) confers a high risk of cardiovascular disease, with an overall prevalence of 4 % in adolescent and about 30% in overweight adolescent [17]. Waist/hip ratio may be the best predictor of these risks [9]. Obesity induced hypertension is associated with increased peripheral resistance and cardiac output,

increased sympathetic tone, increased salt sensitivity , and insulin mediated salt retention ;it is often responsive to weight loss.

Insulin resistance

Hyperinsulinemia and insulin resistance are pervasive features of obesity, increasing with weight gain and decreasing with weight loss. Resistance is due to receptor down regulation; increased free fatty acids impair insulin action; peptides produced by adipocyte like interleukin-6, adiponectin, resistin and tumour necrosis factor alpha have altered expression in obese adipocyte thereby modify insulin action. But most obese person do not develop diabetes , suggesting that the onset of diabetes requires an interaction between obesity induced insulin resistance and other factors that predispose such as impaired insulin secretion[9].

Pulmonary disease

Obesity is associated with reduced chest wall compliance, increased work of breathing, increased minute ventilation due to increased BMR and decreased total lung capacity and functional residual capacity. Obesity may be associated with obstructive sleep apnoea and asthma [9].

Gallstones

Obesity has an increased predisposition to gallstones due to enhanced biliary secretion of cholesterol and super saturation of bile [9].

Bone and joint disease

Obesity is associated with an increased risk of osteoarthritis due to the trauma of added weight bearing and joint alignment. The prevalence of gout may also be increased [9].

Management of obesity

Childhood obesity is a rapidly growing crisis that has reached epidemic magnitude, resulting in an increased prevalence of obesity related morbidities early in life and thus, has put tremendous constraints on the health-care . The development of reasonable approaches to manage this problem is vital. Successful treatment, defined as the sustained maintenance of normal body weight without producing any treatment induced morbidity is rarely achieved in reality. The prevention of obesity in children should be the vital step in the management of obesity. The recognition of obesity and overweight children and their treatment is an important aspect of preventive paediatrics and Public Health [32]. Treatment goals should be guided by the health risks of obesity in any given individual.

It has been found that only 0.5–6.1% of paediatricians actually calculate the BMI for children during their routine visit to clinics [33].The

inability to recognise obesity and overweight in children who are younger has resulted in failure in assessing for the risk factors in them and counselling regarding lifestyle changes and a decreased attempts to screen for co morbidities. Therefore calculating and plotting the BMI of a child in the growth charts at each visit is the first and the foremost step in deciding when to intervene in the child.

The American Academy of Paediatrics [34] (AAP) issued a policy statement in 2003 on the prevention of overweight and obesity in children. They recommended periodic monitoring of growth to prevent obesity in children. The paediatricians should become proficient at identifying children at risk of obesity, plotting the BMI at all visits to know any excessive weight gain, and screening for co morbidities related to obesity. They advocate that paediatricians should encourage breastfeeding, promote healthy dietary habits, physical activity and insist to cut down on sedentary pursuits.

Screening Tests for the More Common Obesity Co-Morbidities [35]

The children with a BMI in at least the 85th percentile are usually to be screened for associated co-morbidities and complications.

1. For Diabetes mellitus:

Fasting plasma glucose >126 mg/dL, or random value >200 mg/dL

(If OGTT used, 2 hr glucose >200)

2. For Dyslipidemia:

Triglycerides >110 mg/dL (75th percentile); 160 mg/dL (90th percentile)

Total cholesterol 180 mg/dL (75th percentile); 200 mg/dL (90th percentile)

3. Hypertension

Blood pressure >90th percentile (standardized according to sex, age, and height percentile)

4. NAFLD

Alanine aminotransferase >2 standard deviation above the mean for the laboratory.

Behaviour modification

The principles of behaviour modification provide the underpinnings for the many current programs of weight reduction. Typically, the person is requested to monitor and record the events related to eating and activity, and rewards are designed to modify the maladaptive behaviours. Counselling during routine clinic visits and family centered programs that support and encourage lifestyle changes are promising in showing positive results. Evaluation of overweight children and their families requires sensitivity and compassion. They have decreased self esteem and psychosocial issues due to the stigma of

being overweight. Obesity is a chronic medical problem whose treatment takes a longer duration. Explaining this concept to the family in an objective and nonjudgmental manner is the stepping stone for the successful treatment of these children. In order to understand what intervention to use to try to help a person to lose weight, we must determine whether each individual is ready to change, to surmount their obesity and to maintain weight loss. So that we can match our approach to the stage at which they are present.

Stages of lifestyle change [36, 37]

S.no	***Stage***	***Behaviour***	***Physician goal***
1	Precontemplation	Not considering change in the behaviour	Move toward thinking about change
2	Contemplation	Considering change in the behaviour	Move toward preparing for change
3	Preparation	Preparing for change	Move toward taking action
4	Action	Establishing the change	Maintain change
5	Maintenance	Struggling to maintain the gains	Maintain change

Endocrine society clinical practice guidelines [35]

Guidelines have been published for the diagnosis and management of obesity in children.

Diagnosis of overweight and obesity

A child can be diagnosed as overweight if the BMI is in at least or more than the 85th percentile but less than the 95th percentile for age and gender, and as obese if the BMI is in at least and more than the 95th percentile for age and gender.

Lifestyle recommendations

Advocate extensive lifestyle (dietary, physical activity, and behavioural) modification for the entire family and the children in an age-appropriate manner.

Dietary recommendations

a. Recommends healthy dietary habits such as avoidance of the consumption of high calorie, nutrient-poor foods (e.g. sweetened beverages, carbonated drinks, fruit drinks, junk foods and calorie-dense snacks).

b. Emphasizes on

• Controlling daily calorie intake in accordance with the guidelines of the American Academy of Paediatrics i.e. as above, to limit in between-meal snacking.

• Increasing the intake of fibre rich diet, fruits, and vegetables (at least five portions/day)

• Eating timely, regular meals, particularly breakfast, and avoiding constant snacking during the day.

Physical activity recommendations

1. Recommends 60 minutes of daily moderate to vigorous physical activity by the children.

2. Advocates reduction in time spent on sedentary activities, such as watching television, playing video or computer games, or surfing internet. Screen time should be limited to 1–2 hours per day, according to the American Academy of Paediatrics.

Promoting improved levels of daily moderate to vigorous physical activity is vital in addressing the matter of obesity in children as changes in the dietary practices alone will not be successful in achieving sustained weight loss. If there is a reduction in caloric intake, the metabolism slows down resulting in decreased calorie use with difficulty in achieving weight loss. Exercise is, therefore, crucial for sustaining the weight loss in children. The increase in physical activity results in increased basal metabolic state, with decrease in insulin resistance (irrespective of weight loss), improved exercise tolerance, and sustenance of weight loss.

Psychosocial recommendations

Suggested that clinicians discuss with parents about the need for healthy child rearing practices related to diet and physical activity including parents as role models for practising healthy dietary and physical activity habits, setting limits of acceptable behaviours, and avoidance of using food as a reward or punishment.

Paediatric clinic based measures, such as personal interviewing, discussing hazards of being overweight, and targeting amendable behaviours, such as television viewing, internet surfing, video games and physical activity, has shown encouraging results[38] but studies have shown relatively high withdrawal rates for families approached with rigorous prevention strategies[39] .The most successful option for the prevention of obesity have children as their target, rather than their parents, teaching them self control of urge ,encouraging reduction in sedentary pursuits and build upon their physical activity[40,41]. Programs for the prevention of obesity among children worldwide have focused on individual-level changes in lifestyle and overall behaviour. Children with severe obesity and suffering from severe co morbidities, who are not able to establish lifestyle changes should be considered for either medical therapy or bariatric surgery, but these choices, should be considered as a last resort in children as their long-term safety has not been evaluated in children so far. Intervention at the earliest opportunity and prevention

strategies are the most critical aspects of dealing with obesity, but they require sustained efforts from both the parents and children to have self-control on their urge and increase their physical activity levels and healthy food habits [42] .If obesity needs to be prevented, and if not prevented lifestyle modification becomes the cornerstone of treatment for obesity.

Far greater resources and efforts must be devoted to the prevention of obesity if we are to halt the progression of this epidemic, let alone reverse it. Our best hope for prevention may lie with children. There is a pressing need for wide-scale environmental interventions to reduce the number of individuals who require such treatment.

REVIEW OF LITERATURE

Global prevalence

- The global prevalence of overweight (including obesity) in children aged 5-17 years is estimated by the World Health Organization (WHO), International Obesity Task Force (IOTF) to be approximately 10%[7]
- The prevalence rates of obesity (BMI exceeding the 95th percentile) among U.S. children and adolescents aged 6–11 and 12–19 years, respectively were 15.3 and 15.5% in 1999–2000 [4,43].
- The cost of obesity management accounted for 6.8% (or US$ 70 billion) of total health care costs in the United States in 1995[44].In several developed countries obesity has been estimated to account for 2-7% of the total health care costs (WHO TRS 894)[45].

Indian scenario

- Mehta, et al conducted a study on obesity amongst the affluent adolescent girls at Delhi and found the prevalence of obesity and overweight to be 5.3% and 15.2% respectively [46].
- Kaur, et al found the prevalence of obesity and overweight in Low Income Group school children to be 0.1 and 2.7 percent respectively, amongst Middle Income Group school children it was 0.6 and 6.5 percent, in High Income Group school children it was 6.8 and 15.3 percent respectively (p<0001) in Delhi[47].

- A study conducted in a Pune school by Khalider, et al documented the prevalence of obesity to be 5.7% and overweight as 19.9%[48]

Tamilnadu scenario

- Ramachandran, *et al* [49]–studied children from six schools in Chennai, two each from high, middle, and lower income groups. The prevalence of overweight (including obese) adolescents ranged from 22% in well off schools to 4.5% in lower income group schools.

- Shabana, et al found the overall prevalence of overweight to be 12.1% among the children and 15.5 % among the adolescents in Chennai schools irrespective of socioeconomic status and gender [50].

- Subramanyam, *et al.* [51] showed the prevalence of overweight and obesity among well-off girls aged 10- 15 years in Chennai to be 9.6% and 6.2% respectively in 1998.

Risk factors for obesity

- Laxmiah, et al conducted a study among school children in Hyderabad and found that overweight and obesity were marginally higher among adolescents who were not involved in physical activities and who were sedentary, watching television ≥3 h/d,

was significantly higher (10.4%) compared with those who watched 0 or <3 h/d (5.9% to 6.3%) [52].

- In the study by Shabana, et al , the multiple logistic regression analysis of several risk factors showed that the higher income group and watching TV for more than 2 hours daily were associated with obesity to a greater extent [50].
- Subramanyam, et al found that only 30 % of the overweight and obese children indulged in at least 60 minutes of daily physical activity, which is reminiscent of the sedentary lifestyle of the younger age group [51].
- Study[53] conducted in neighbouring Andhra Pradesh revealed the average duration of watching TV on school day was found to be significantly ($p < 0.05$) higher among the overweight (1.4hrs/day). The proportion of adolescents, who were participating in outdoor games was significantly ($p < 0.001$) lower among the overweight. (54.5%). The prevalence of overweight and obesity was significantly higher among the adolescents, who had calorie intake ≥70% of RDA as compared to <70% of RDA, with respect to protein (54.9% Vs 30.9%) and energy (50.8% Vs 30.4%). The frequency of intake of fast foods was significantly ($p < 0.05$) higher among the overweight children.

- The 2003 Youth Risk Behaviour Surveillance Study and the 2002 Youth Media Campaign Longitudinal Survey [55] showed that many children and adolescents did not meet the recommended levels of daily physical activity. Only 62.6% of students in the ninth through twelfth grades met the recommendations for vigorous physical activity (≥20 minutes on ≥3 of the past 7 days), and 24.7% of students met recommendations for moderate physical activity (≥30 minutes on ≥5 of the past 7 days). On the whole only 33% of students reported some but insufficient levels of physical activity, and 11.5% reported no moderate or vigorous physical activity. In addition, 38.2% reported watching >3 hours of television per day. Twenty-three percent of younger children (9–12 years of age) had not engaged in any physical activity outside of school in the past 7 days, and 61.5% had not participated in any physical activity during nonschool hours.
- The prevalence of obesity was higher among the adolescents who were fond of junk foods (12.6% ; 95% CI: 8.6, 16.6) in a study done by Laxmaiah, et al in Hyderabad[52]

- The frequency of intake of fast foods such as burgers and noodles was significantly ($p < 0.05$) higher among the overweight persons in a study in Andhra Pradesh [53].

- In a study by Bell, et al showed that each extra glass of sugar-sweetened drink consumed every day increases the risk of becoming overweight by 60% [54].

- A study by Keski, et al [56] has shown that children and adolescents who skipped breakfast have higher BMI and a higher risk of obesity compared to those who took breakfast regularly.

Intervention studies

- In a lifestyle intervention study done among obese Brazilian adolescents, 63% (girls) and 77% (boys) completed 6 months of a multidisciplinary lifestyle therapy with more than 75% compliance in all exercise, nutritional, psychological, and clinical sessions. For both genders, the dropout rate before 12 weeks was 12% [57]. The attrition rate in the program was ~46%

- Meg Zeller, et al conducted a weight management program to find out the predictors of attrition. Fifty-five percent of patients

withdrew prematurely from treatment. Noncompleters were more likely to be Medicaid recipients, black, older, and self-report greater depressive symptomatology and lower self-esteem [58].

- One interdisciplinary intervention program in the USA by Robinson, et al featured a school based approach to influence eating patterns, reduce sedentary behaviours (with a strong emphasis on television viewing), and promote higher activity levels among children of school grades 6 to 8. Evaluation at two years showed a reduction in obesity prevalence in girls (OR = 0.47; 95%CI: 0.24 – 0.93), but not in boys (OR = 0.85; 95%CI: 0.52 – 1.39). The reduction in television viewing (by approximately 30 min/day) was highly significant for both boys and girls, it seems that reduced eating in front of the television is at least as important as increasing activity [59].
- The Planet Health intervention in schools in the Boston was a large randomised control trial in behaviour intervention. This comparatively large trial used a complex intervention to the school curriculum (such as improved physical education), changes to school meal provision, targeted reductions in television viewing, and promotion of walking to/from school. The intervention was successful (in girls, not in boys) in that risk of becoming obese was

significantly reduced (AOR 0.47, 95% CI 0.24 to 0.93), and there was a significant remission of existing obesity in those who were obese at the start of the trial (AOR 2.16, 95% CI 1.07 to 4.35). The benefits of the intervention were attributable largely to deductions in television watching [60].

- Studies of dietary counselling by physicians indicate that even brief communication about diet can influence behaviour and that the magnitude of the effect is related to the strength of the intervention [61].
- In a intervention study done by Thornas et al in Germany, children younger than 12 years had an odds ratio of 4.1 (95% confidence interval 3.0–5.5, $P < 0.001$) for decrease in the BMI at 2-year follow-up as compared to older children. Because the highest possibility to decrease overweight was found in children younger than 12 years (fourfold increase as compared to children older than 11 years), this study emphasised the necessity of an early intervention in childhood obesity [62].
- RESCATE study performed as a randomized controlled field trial in 498 children aged 8–10 years from 10 public schools of low socioeconomic status in Mexico City showed a significant increase in the performance of moderate physical activity among children in intervention group who had not performed MPA at baseline any

day of the week (40%, $P = 0.04$) but not in the control group (8%, P = not significant) after a follow up period of 1 year. They also showed a significant reduction in the proportion of children who spent more than 3 hours a day playing video games (from 23 to 13%, $P = 0.01$), while control group did not show significant changes. The intervention was able to modify positively physical activity and reduce time spent on such sedentary activities as video games among those at highest risk [63].

- The CATCH intervention was able to modify the fat content of school lunches ($p<0.001$), increase moderate-to-vigorous physical activity ($p< 0.003$) and improve eating and physical activity behaviours in children during 3 school years [64].
- James, et al reported a significant decrease in the incidence of obesity after 1 year of follow up among 7- to 11-year-old children who received an intervention to decrease carbonated beverages [65].
- Significant progress in nutrition knowledge was seen in all children ($p < 0.01$) between baseline and post-intervention in a study conducted by Warren et al. The fruit and vegetable intake increased significantly ($p < 0.01$ and <0.05, respectively). No significant changes in the rates of overweight and obesity were seen as a result of the intervention. [66].

❖ Yedavdekar rajiv et al showed BMI was significantly reduced among overweight & obese boys & girls ($p < 0.05$ and $p < 0.01$ respectively)[67] in a school intervention study.

STUDY JUSTIFICATION

- Childhood obesity is on an unexpectantly increasing trend throughout the world in past few decades. So efforts to curb obesity must begin early in life because obesity in childhood is likely to persist into adulthood and result in early onset of co morbid conditions.

- Childhood provides an important opportunity to establish healthy eating and physical activity behavior as they are much more flexible than adults, to protect them against future obesity.

- As there is no proven efficacy for pharmacotherapy and surgery in management of obese children, lifestyle modifications is the crucial aspect in the management of these children.

- Compliance to the lifestyle modifications is the key in the successful outcome of these measures.

- The commitment of parents is vital to help the child develop healthy habits and to make them compliant to the lifestyle changes. They can serve as role models, authority figure and behaviorist to mould their children's habit.

- Schools are probably the ideal medium of intervention as they are central to children's life and information can be relatively quickly dissipated.

AIM OF THE STUDY

To study

a) The level of compliance among obese/ overweight school children in the age group of 7-12 years for life style interventions

b) Effect of the lifestyle modifications on their body mass index.

SUBJECTS AND METHOD

Methodology

Study design

Intervention study ; Behaviour modification study

Study period

Time Schedule : January 2010- October 2011

Study population & place

School children in the age group of 7-12 yrs at the government schools affiliated to ICH & HC for the school health programs who meet the inclusion criteria. The ratio of boys and girls was fixed to be in 1:1 ratio.

Sample size

On the basis of level of compliance observed in previous similar study i.e 75% [57] and prevalence of obesity in our population observed in studies [49,50,51] , the sample size was calculated using sample size calculator ,survey software[78] and deduced to be 350.The male : female ratio was fixed to be 1:1.

Inclusion criteria

- Children in the age group of 7-12 years whose BMI = or > 85th percentile for age and gender (International obesity task force 2000) based on WHO BMI index chart for boys & girls.

Exclusion criteria

- Children with chronic medical illness
- Children with chronic drug intake
- Diastolic blood pressure >90th percentile (standardized according to sex and age percentile)
- Children with abnormal biochemical parameters

1. Random blood sugar value >200 mg/dL
2. Triglycerides >110 mg/dL
3. Total cholesterol >180 mg/dL
4. Thyroid stimulating hormone >6.4 mIU/l

Variable definition

- ***Anthropometry***

Weight was measured using bathroom weighing scale to the nearest 500 grams. Height was measured using wall scale on a flat surface with no footwear to the nearest 0.1 centimetre.

- ***BMI criteria***

BMI has become standard as a reliable indicator of overweight and obesity.

$$BMI = \frac{\text{weight in kg}}{(\text{Height in meters})^2}$$

The WHO BMI percentile chart/table (5-19years) published in 2007 was used for plotting the BMI as recommended by IAP.

Based on the International Obesity Task Force 2000 (IOTF), the children are classified as below

< 5th percentile for age and gender	Underweight
5th-84th percentile for age and gender	Healthy weight
85th-94th percentile for age and gender	Overweight
>/=95th percentile for age and gender	Obesity

- ***Measurement of calorie intake***

The child and the parent were asked to note down the diet child consumed (type and amount of food) for 3 consecutive days

in a health diary to avoid any recall bias and the average calorie intake per day was calculated from it. They were asked to do so prior to each visit and reminded over phone. Whether they ate breakfast on a daily basis was asked about. They were expected to eat breakfast on all days. They were asked about the intake of junk food and sweetened carbonated drinks, which when consumed on 2 or greater days were considered significant risk factor for weight gain. Their habit of consuming snacks while watching television is also noted.

- ***Measurement of physical activity***

The amount on time the children spend on moderate physical activities like walking, cycling, outdoor games, martial arts, dancing etc. are measured in minutes per day. One hour of physical activity is the recommended daily.

- ***Measurement of sedentary activity***

The sedentary activities like watching television, playing computer games, internet surfing, video games were measured in hours. It is recommended to decrease the sedentary activity to less than 1 hour/day.

- ***Family history***

Documented evidence of obesity, overweight, diabetes mellitus, stroke, coronary artery disease, hypertension in parents, sibling, paternal and maternal grandparents.

- ***Random blood sugar***

The blood sugar was measured by Trinder's method. The normal range for the children is 60-100 mg/dl.

- ***Serum triglyceride***

The serum triglyceride was measured by CHOD-PAP method. The normal range is 40-80 mg/dl.

- ***Serum cholesterol***

The serum triglyceride was measured by GPO-PAP and the normal range is 125-175 mg/dl.

- ***Serum TSH***

The normal range for children is 0.7-6.4 mIU/l.

- ***Compliance***

The children were decided to be compliant if they follow the recommended interventions for more than 80% of the month.

Manoeuvre

The ethical clearance was obtained for the study from the Institutional review board. 16 government schools affiliated to ICH&HC were selected by simple random sampling. Due permission was obtained from the principal of the school after explaining the study in detail. Initial screening of the children in the age group of 7-12 years by anthropometric measurement and physical examination. Using the WHO growth chart and recommendation made by International task force for obesity, overweight and obese children were identified. After obtaining written consent from parents and oral consent from the children, blood was drawn. Random blood sugar, thyroid function test, serum cholesterol and serum triglyceride were measured. The reports of the laboratory parameters were given to parents. Children with abnormal laboratory parameters were excluded from the study and referred to ICH&HC for further management. The children enrolled in the study were asked to bring their parents for a counselling session. Both the parents and children were interviewed independently to know the current lifestyle practices, family history, symptoms suggestive of co morbid condition. Counselling was given regarding the nature of the disease, the effect of adverse lifestyle practices, its co morbidities, the risk of adult onset disease and the need to bring about drastic changes in the lifestyle and maintain it on a long term basis to bring down the BMI and its adverse

outcome. The data was noted in the questionnaire. The parents and children were advised regarding the interventions to follow. The parents were asked to make note of the events in the health diary provided to them on daily basis. The children were followed up at regular intervals for a period of one year. They asked about the compliance for the interventions advised and cross-checked with the health diary. The BMI was calculated at the end of the follow up.

Interventions

Activity

- Restrict TV viewing / computer games, video games, internet surfing to less than an hour daily.
- Watch television under parental supervision.
- Parents should restrict their own TV viewing to less than an hour daily.
- Forbid snacks during TV viewing to < 2 occasions/week.
- Time scheme for TV watching.
- Involve the child in active physical work for at least an hour a day.

  Walking / jogging in nearby park

  Walk to school / place of worship / shop if in walk able distance.

Outdoor games / cycling / skipping

- Early to bed & early to rise. To have 8 hours of restful sleep.
- Plan academics so as to spare an hour to play daily.

Nutrition

- To follow meal plan with optimum calorie for age/gender (to be individualized)
- Avoid snacks, junk foods, sweetened carbonated drinks <2 occasion/week.
- To have breakfast daily.

Statistical analysis

- ✓ Statistical analysis was done using SSPS software 17.0version.
- ✓ Anthropometric measurements are given in mean and standard deviation.
- ✓ Pre and post intervention evaluation of life style modifications was analyzed by Mcnemar's test for discrete data and paired student t test for the continuos data.
- ✓ p value < 0.05 was taken as statistically significant.

OBSERVATION AND ANALYSIS

350 children were enrolled in the study on the basis of inclusion and exclusion criteria. The male and female were chosen in the ratio of 1:1 (male 175: female 175). 12 children were lost for follow up. The reasons for the lost follow up being change of school in 4 children and poor cooperation from parents in 12 children.

Characteristics of study population

Age

Among 350 children in our study, 146 (41.7%) children belonged to 11-12 years age group, 141(40.3%) were in 9-10 years group and 63(18%) children were in the age group of 7-8 years (Fig 1).

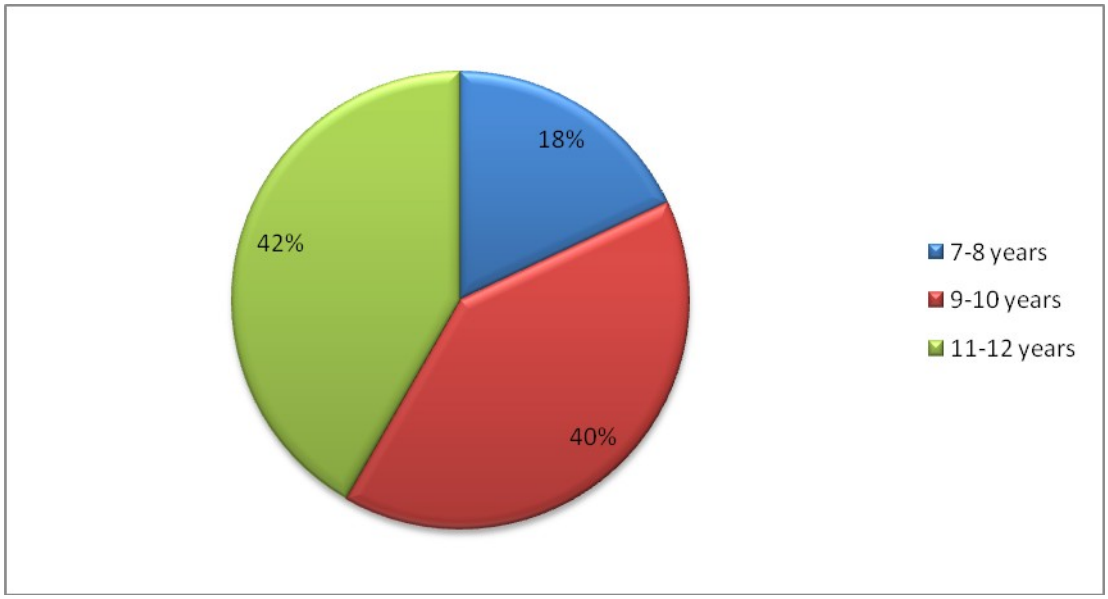

Figure 1.Age wise distribution of the study population

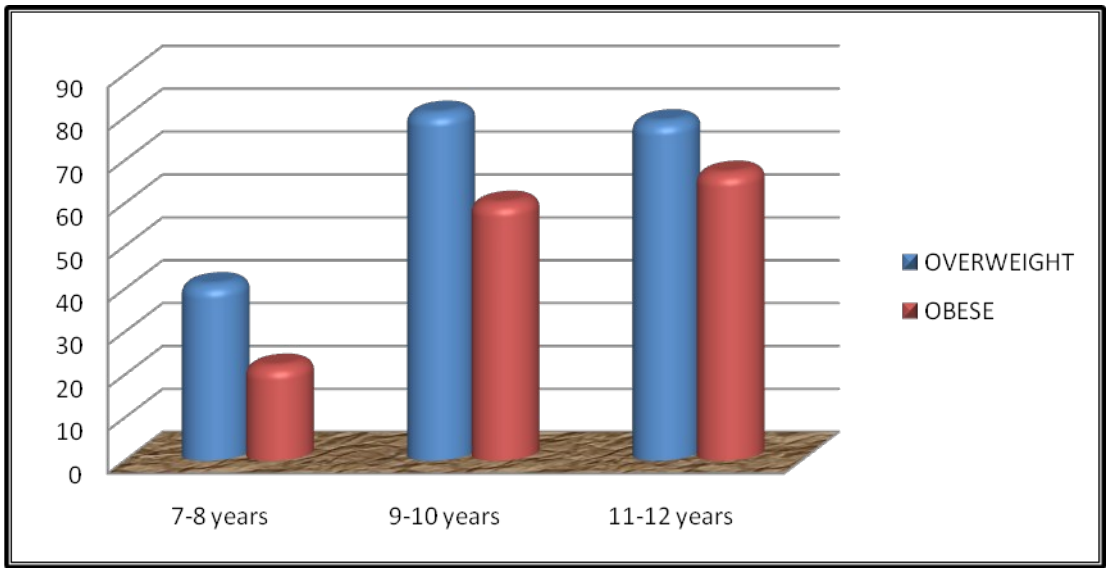

Figure 2.Age wise distribution of obese and overweight

Among 7-8 years age group, 41 (65.07%) children were overweight and 22 (34.92%) were obese. In the 9-10 year age group children, 81 (55.44%) were overweight while the rest of 60 (42.55%) children were found to be obese. 79 (54.1%) children in the age group of 11-12 years were overweight and 67 (45.89%) were obese as depicted in fig.2.

Gender

Among the children in 7-8 years age group, 34 males were found to have increased incidence of being overweight/obesity than females (n=29). Similar results were observed in the age group of 9-10 years i.e. male (n=89) and female (n=52). However in the age group of 11 to 12 years, female (n=94) were found to outnumber the male (n=52) as depicted in Fig 3.

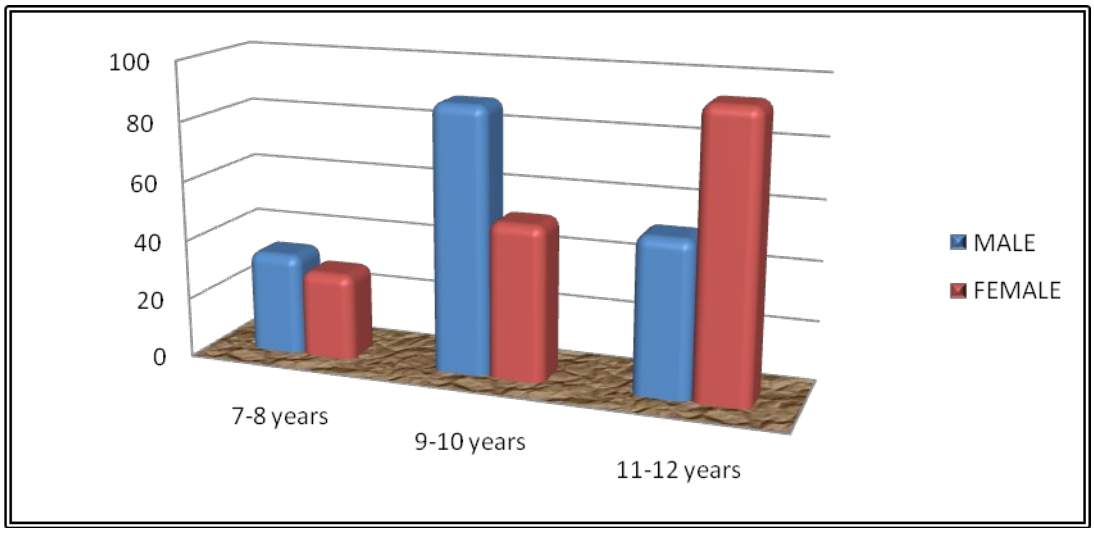

Figure 3.Gender wise distribution of the study population

Anthropometry

Table.1.Anthropometric measurement of the study population

Anthropometry	Age Group	Mean	Standard deviation
Weight in kgs	7-8 years	27.13	3.235
	9-10 years	36.21	3.927
	11-12 years	43.97	4.376
Height in cms	7-8 years	116.95	4.740
	9-10 years	128.26	5.730
	11-12 years	136.32	6.876
BMI	7-8 years	19.73	1.308
	9-10 years	21.79	1.531
	11-12 years	23.58	1.819

Table. 2. Anthropometry measurements (gender wise)

		Mean	Standard Deviation	t value	Sig.(2-tailed)
Wt in kg	Female	39.11	7.422		
	Male	36.50	6.985	3.390	.001
Ht in cm	Female	130.15	9.709		
	Male	129.02	8.734	1.152	.250
BMI	Female	22.67	2.327		
	Male	21.66	1.809	4.518	.000

The mean weight of the female children included in the study was 39.11 kg and the male was 36.50 kg, which was a statistically significant difference (p=0.001). The mean height was found to be 130.15 cm for

female and 129.02 cm for the male children. The difference did not achieve statistical significance (p=0.250). There was found to be a statistically significant difference in the body mass index between the genders (p=0.000) with a mean of 22.67 for female and 21.66 for male children. The anthropometric measurements were found to be higher in female children in all the age groups.

BMI

Among the 350 children, 201 (57.42%) were overweight and 149 (42.57%) children were obese for their age and gender (Fig 4).

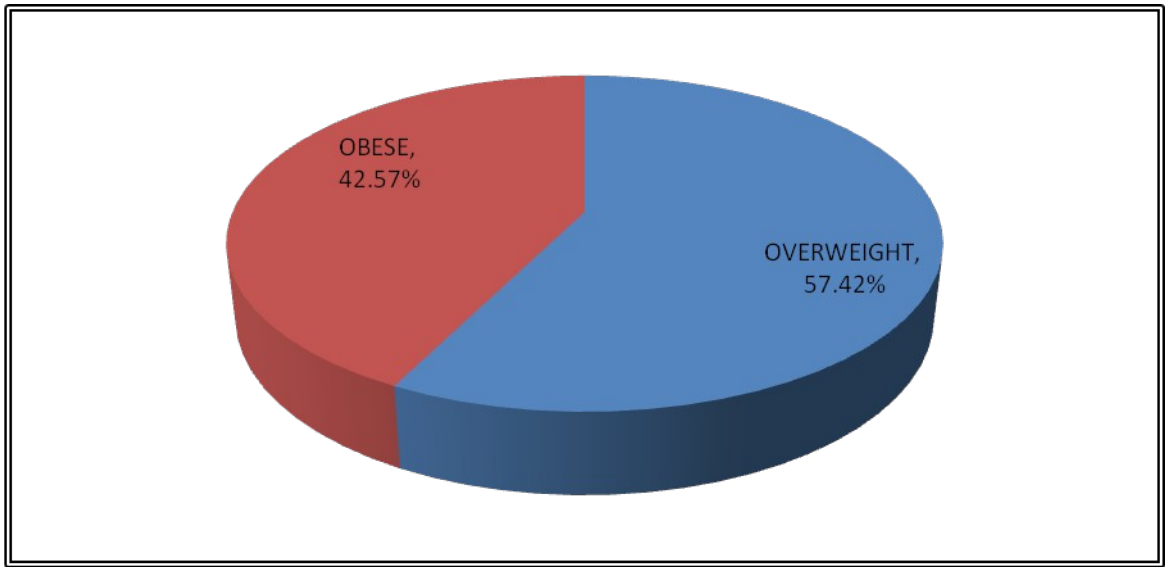

Figure 4Proportion of overweight and obese children

Family history

In the study population, there was a family history of obesity in 20 children (5.7%), diabetes mellitus in 110 (31.4%), hypertension in 30 children (8.6%) and stroke in 7 children (4.7%). There was no significant difference observed for the above factors between the obese and overweight children. 11.6% of the study population had a family history of coronary artery disease, there was found to be statistically significant difference (p=0.000), with the obese children having greater preponderance.

Table.3. Comparison of family history of risk factors between obese and overweight children

Family history	**Overweight n (%)**	**Obese n (%)**	**X^2 value**	**Significance p**
Obesity	11(3.1%)	9(2.6%)	0.051	0.820
Diabetes mellitus	70 (20%)	40 (11.4%)	2.259	0.130
Hypertension	20(5.7%)	10(2.9%)	1.145	0.337
Coronary artery disease	3 (1.5%)	15 (10.1%)	12.896	0.000
Stroke	1(3%)	6(1.7%)	5.438	0.045

Co morbid conditions

Among the 350 children, 8.9% (n=31) had breathlessness and 33.4% (n=117) children had wheezing problems. 17.7 % (n=62) of the children had vague abdominal pain, 21.1% (n=77) had heart burns while another 9.2% (n=32) had sleep disturbances. There was no eating disorder, chest or joint pain in our study population.

Tab.4. Comparison of symptomatology between obese and overweight children

Symptoms	Overweight n (%)	Obese n (%)	X^2 Value	Significance (p)
Breathlessness	3(0.9%)	28(8%)	31.722	0.000
Wheezing	50(14.3%)	67(19.1%)	15.520	0.000
Abdominal pain	39(11.1%)	23(6.6%)	0.924	0.396
Heart burns	28(7.1%)	49(14%)	21.459	0.000
Sleep disturbances	3(0.9%)	29(8.3%)	33.266	0.000

ANALYSIS OF LIFESTYLE PRIOR TO INTERVENTION

In our study population, nearly 83.7% (n=293) of the children had moderate physical activity of less than an hour per day. Only 16.3%

(n=57) had the recommended physical activity of at least an hour per day. The overweight children had an average of 39.5 minutes (S.D=24.820) of physical activity per day while the obese children had 41.95 minutes (S.D=20.006). There was no statistically significant difference between the obese and overweight children (p=0.334). 52 children (92.1%) in the age group of 7-8 years exerted physically for less than an hour a day, while it was 119 children (84.4%) in the 9-10 years and 116 children (79.5%) in the 11-12 years group.

Table.5. Activity of the obese and overweight children prior to intervention

Activity	**Overweight n (%)**		**Obese n (%)**		**Total n (%)**	
	< 1 hr	**>1 hr**	**< 1 hr**	**>1 hr**	**< 1 hr**	**>1 hr**
Physical activity	170 48.6%	31 8.9%	123 35.1%	26 7.4%	293 83.7%	57 16.3%
TV watching	33 9.4%	168 48%	16 4.6%	133 38%	49 14%	301 86%

Computer/ Video games	166 47.4%	35 10%	134 38.3%	15 4.3%	300 85.7%	50 14.3%

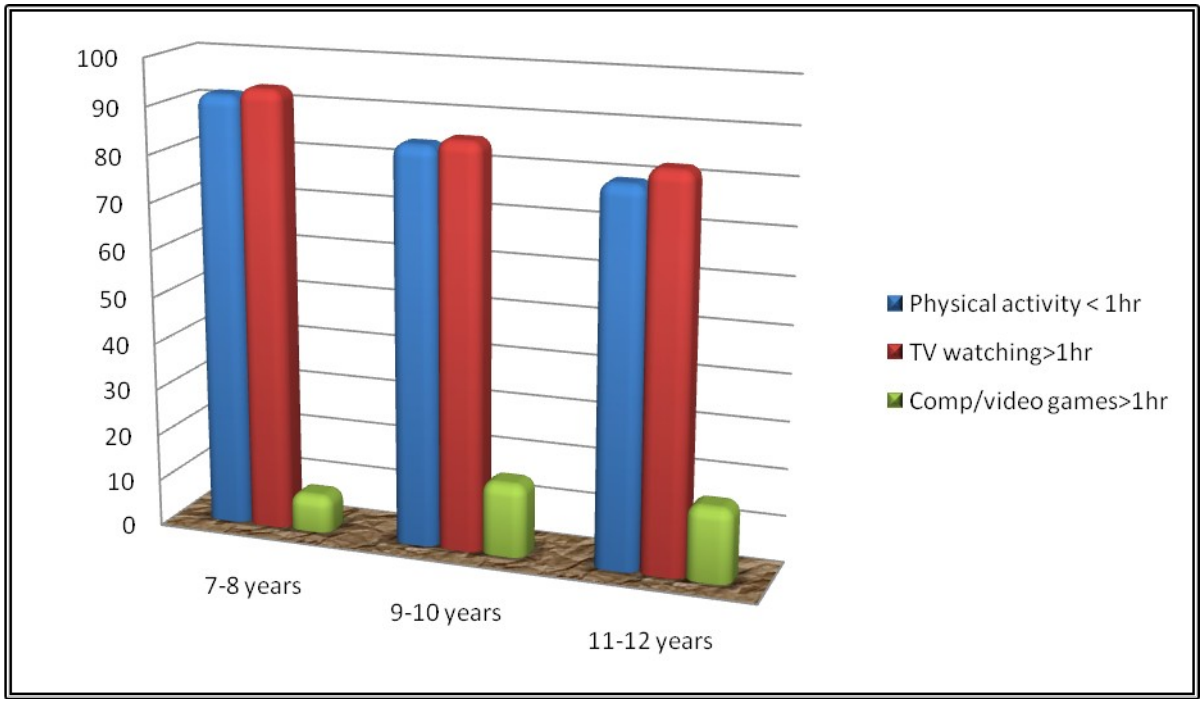

Figure 5.Activity of children prior to intervention; age wise (in percentages)

In our study population, nearly 83.7% (n=293) of the children had moderate physical activity of less than an hour per day. Only 16.3% (n=57) had the recommended physical activity of at least an hour per day. The overweight children had an average of 39.5 minutes (S.D=24.820) of physical activity per day while the obese children had 41.95 minutes (S.D=20.006). There was no statistically significant difference between the obese and overweight children (p=0.334). 52 children (92.1%) in the age group of 7-8 years exerted physically for less than an hour a day,

while it was 119 children (84.4%) in the 9-10 years and 116 children (79.5%) in the 11-12 years group.

Among the study population, 301 children (86%) watched television more than an hour a day, with only 49 (14%) children having screen time less than 1 hour per day. The mean time spent on television watching was 2.81 hours/day (S.D=1.049) by the obese children and 2.34 hours/day (S.D=0.903) by the overweight children with a statistically significant difference (p=0.000). 93.7% (n=59) of the children in the age group of 7 to 8 years had a screen time greater than 1 hour/day. About 85.8% of the children (n=121) in the 9-10 years age group and 82.9 % (n=121) in the age group of 11-12 years watched television for more than an hour a day.

50 (14.3%) children among our study population played computer/ video/mobile games more than an hour per day. The average time spent on this sedentary activity was 0.38 hr/day (S.D=0.827) by the obese children and 0.40 hour/day (S.D=0.884) by the overweight children with no statistically significant difference (p=0.826).

7.9% (n=5) of the children in the age group of 7 to 8 years had this sedentary activity lasting greater than 1 hour per day. While it was 15.6% (n=22) in the 9-10 year old children and 15.8 %(n=23) in the age group

of 11-12 years. Nearly 58.6% (n=205) of the children were not supervised by the parents during internet surfing/television watching.

Table.6.Dietary practices of the study population prior to intervention

Parameters	Overweight n (%)	Obese n (%)	Total n (%)	Significance (p)
Excess Calorie intake	166 47.4%	145 41.4%	311 88.9%	0.000
Skipping Breakfast	61 17.4%	95 27.1%	156 44.6%	0.000
Junk food >/=2 per week	143 40.9%	122 81.9%	265 75.7%	0.023
Snacks during TV >/=2 per week	115 32.9%	106 30.3%	221 63.1%	0.010

Among the study population, 311(88.9%) of the children were consuming more than the recommended calories for their age and gender. Among the obese children 145 (41.4%) and 166 (47.4%) of the overweight children ate excess calories with statistically significant difference (p=0.000) between the two groups. Among the 7 to 8 year age

group children, 90.47 %(n=57) ate calories excess for their age and gender, while it was 87.2 %(n=123) among 9-10 year old children and 89.7% (n=131) in the 11-12 years age group. The average calorie intake of the obese children was 2341.98 kilocalories (S.D=228.29) and 2253.39 kilocalories (S.D=267.90) for the overweight children, which is statistically significant (p=0.003).

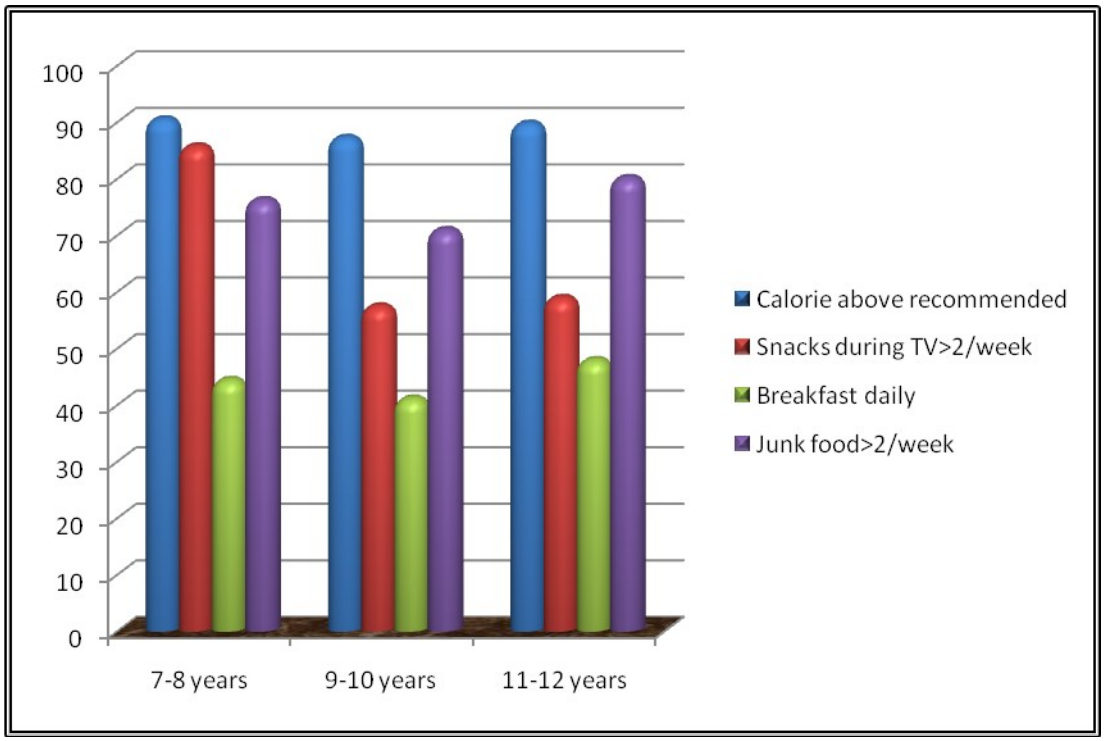

Figure 6. Comparison of dietary practices of children (age wise)

44.6% (n=156) of the children among the 350 children skipped their daily breakfast. Coming to the age wise distribution, 44.4% (n=28) of the children in the 7-8 years age group skipped breakfast on most days. 41.1 % of the children (n=58) in the 9-10 years and 47.9 % (n=70) children in the 11-12 years group skipped breakfast.

265 children (75.7%) of the 350 children had consumed junk food on 2 or more occasions in a week.76.2% (n=48) of the 7-8 year old children had junk food on most of the days. Among the 9-10 year old children it was 70.9% (n=100) and 80.1% (n=117) among the 11-12 year old group who consumed junk food on 2 or more occasions per week. The habit of eating snacks (i.e.2 or more /week) while watching TV was found in 221 (63.1%) of the study population. The habit was found to be higher in the 7-8 year age group children 54 (85.7%), while it was seen in 81 children (57.4%) in the age group of 9-10 years and 86 (58.9%) in the 11-12 year age group.

ANALYSIS OF POST INTERVENTION PARAMETERS

The physical and sedentary activity of the 338 children, their dietary practices and body mass index after a year of follow up were measured and analysed using Mcnemar test and paired t test to study the effect of the intervention.

Activity of children-post intervention

In post intervention with reference to lifestyle behaviour, significant change has been observed in the children. 54.4% of the 350 children had more than an hour of moderate physical activity per day, while only 16.3% of the children had the recommended physical activity prior to the intervention. From 14% of the children, prior to intervention,

who watched television for less than an hour per day it has increased to 61.8% of the study population after the intervention. Similarly the children who played computer/video/mobile games for less than hour per day increased from 85.7% to 95.3% of the study population following the intervention. By McNemar's test, the difference observed here was found to be statistically significant (p=0.000).

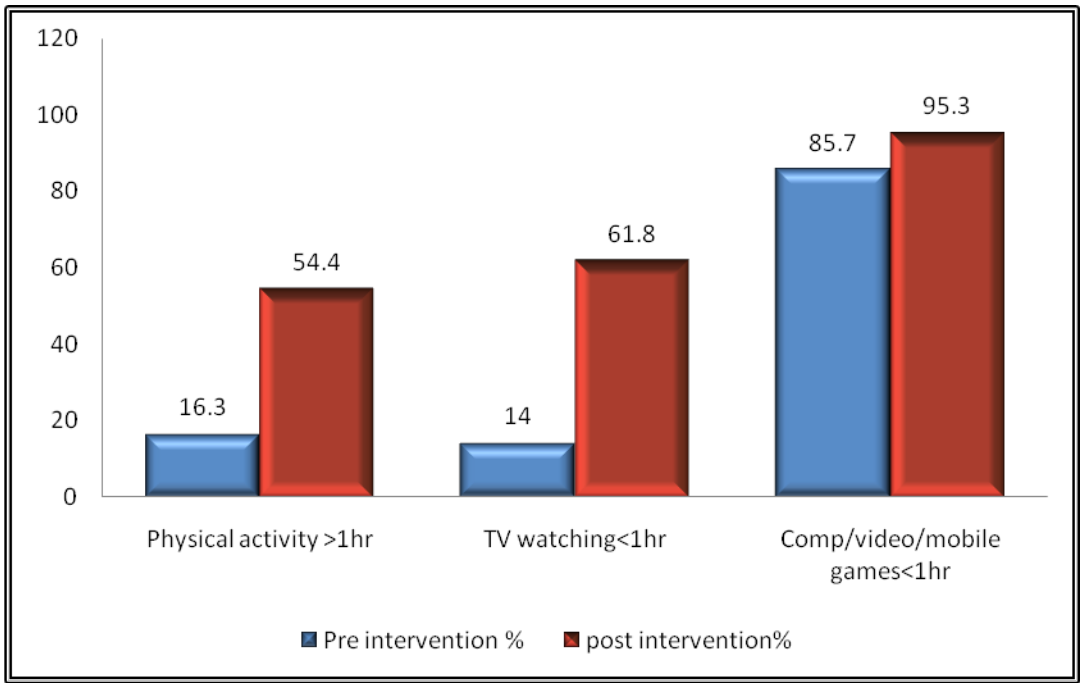

Figure 7.Comparison of pre and post intervention activity of the study population

The average time spent by the children on moderate physical activity prior to the intervention was 41.08 minutes (S.D=22.725) while post intervention it increased to 61.66 minutes (S.D=27.087), the difference observed was found to be statistically significant (p=0.000). Among the three age groups, significant improvement in the physical activity was observed in the 9-10 years old children (64.4%). The

improvement was 35% in the age group of 7-8 years and 52.4% in the children of 11-12 years (p=0.001). Significant decrease in the sedentary activity was observed in the age group of 11-12 years (66.4%) followed by 9-10 year old children (63%) and 48.3% in the children of 7-8 years of age (p=0.050).

Tab.7. Comparison of activity of children; pre vs. post intervention

Parameters	Study population n (%)		Kappa value	P
	Pre intervention	Post intervention		
Physical activity <1 hr	293 83.7%	154 45.6%	0.285	0.000
TV Watching >1 hr	301 86%	129 38.2%	0.185	0.000
Computer/video /mobile game >1 hr	50 14.3%	16 4.7%	0.453	0.000

After the intervention, the children with poor physical activity (<1 hr) decreased from 83.7% (n=293) of the children prior to intervention to 45.6% (n=154). The children who watched television more than a hour a

day decreased from 86% (n=301) of the children to 38.2 %(n=129) following the intervention. On a similar note those who had sedentary pursuits greater than an hour a day plummeted from 14.3% (n=50) to 4.7 %(n= 16) post intervention. The difference was found to have statistical significance.

Dietary practices-post intervention

Following dietary interventions, the calorie intake appropriate for the age and gender showed a dramatic increase from 11.1% prior to intervention to 69.8% in our study population. By MCnemar test, the improved dietary habit after the intervention was significant (p=0.000). The average calorie intake after the intervention was found to be 1969.59 kilocalories/day (S.D=285.55). On an average, the calorie intake has decreased by 321.49 kilocalories /day (S.D=264.99) after the intervention, was found to be statistically significant (p=0.000) .

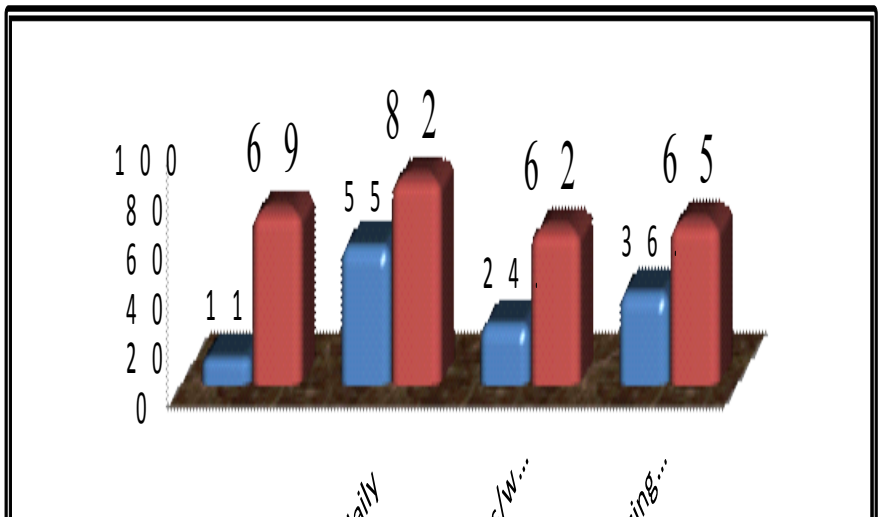

Figure 8. Comparison of pre and post intervention dietary practices

The reduction in junk food intake (i.e. less than 2 days per week) has substantially improved following the intervention from 24.3% of the children prior to 62.4% of the children. Similarly the intake of snacks during television watching has also plummeted from 65.1% of the study population to 34.9% subsequent to the intervention. The habit of having breakfast daily has enhanced from 55.4% of the children prior to the intervention to 88.2% following the intervention. There was found to be a

statistically significant difference in the pre and post intervention dietary habits (p=0.000).

Table.8.Dietary practices of the study population –pre vs. post intervention

Parameters	Study population n (%)		Kappa value	p
	Pre intervention	Post intervention		
Excess Calorie intake	311 88.9%	102 30.2%	0.072	0.000
Skipping Breakfast	156 44.6%	58 17.2%	0.408	0.000
Junk food >/=2 per wk	265 75.7%	127 37.6%	0.323	0.000
Snacks during TV >/=2 per wk	221 63.1%	118 34.9%	0.474	0.000

The improvement in the recommended dietary intervention was better observed in the 9-10 year old children for eating breakfast daily, reduction in the consumption of junk food and snacks during TV watching (86.7%, 68.9%, 69.6%) respectively. The corresponding figures for 7-8 year old children and 11-12 year old children were 85%, 61.7%, 60% and 78.3%, 56.6%, 62.9% respectively.

Analysis of BMI– post intervention

The following tables 9, 10, 11 shows the distribution of the study population in specific BMI ranges both prior to and following the

intervention. It clearly demonstrates the decrease in the BMI in the study population. 12 children who were lost for follow up were not accounted for the calculation of BMI in the post intervention period. The children lost to follow up were 3 in the 7-8 years group,6 in the 9-10 year age group and 3 in the 11-12 year age group. On the whole, 130 (38.4%) children demonstrated a reduction in their BMI following the intervention. 205 children (60.6%) maintained their BMI without any change after the intervention. 3 (0.8%) children were found to have an increased BMI after the intervention than prior to it.

Table.9.BMI of children in the 7-8 year age group; pre vs. Post intervention

BMI range	**16 – 18**		**18.1 - 20**		**20.1 - 22**		**22.1 - 24**	
	Pre n	**Post n**	**Pre n**	**Post n**	**Pre n**	**Post n**	**Pre n**	**Post n**
	-	8	38	30	21	18	4	4

Table.10.BMI of children in the 9-10 year age group; pre vs. Post intervention

BMI range	**17-19**	**19.1 - 21**	**21.1 - 23**	**23.1 - 25**

	Pre n	Post n	Pre n	Post n	Pre n	Post n	Pre n	Post n
	4	16	53	44	54	52	30	22

Table.11.BMI of children in the 10-11 year age group; pre vs. Post intervention

BMI range	16 – 19		19.1 - 22		22.1 - 25		25.1 - 27	
	Pre n	Post n	Pre n	Post n	Pre n	Post n	Pre n	Post n
	-	3	24	32	86	79	36	30

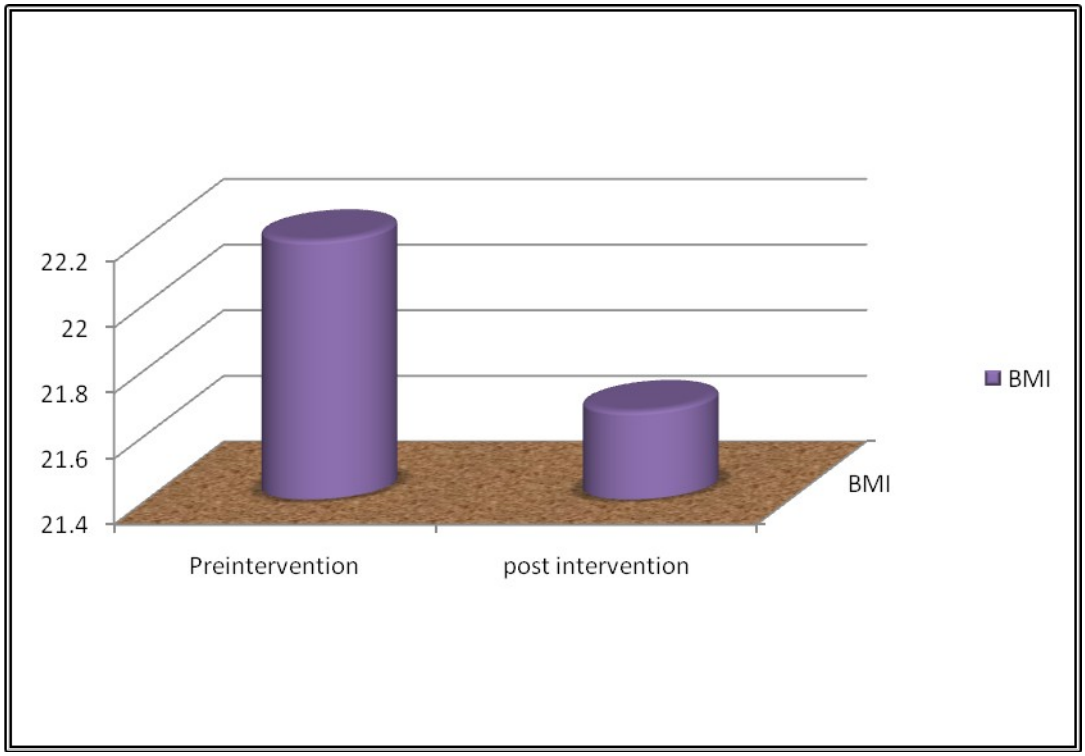

Figure 9Change in BMI following the intervention

The mean BMI of the children (n=338) included in the study was 21.67 after the intervention, with a mean difference of 0.512 from the

BMI prior to the intervention. The reduction in the body mass index following the intervention was found to be statistically significant (p=0.000).

DISCUSSION

The epidemic of obesity has posed a greater burden on the health of the people and the health care system. It requires greater perseverance, effort and resources to halt the progression of the epidemic, if not to reverse it. Most of the obese children grow on to become obese adults and have an early onset of co morbid conditions. Behaviours are usually cultivated early in life and children are the ones who are going to be role models in future. The rampant surge of junk food, invasion of internet and television in the playtime of children and reduced physical activity have emerged as the major culprits in the causation of obesity. This emphasises the need to bring about drastic changes to the current lifestyle of the children. It is not alone sufficient to bring about the changes in

lifestyle but the imperative aspect is to maintain this behaviour change for longer periods as many studies have shown that people tend to regain weight once they discontinue the interventions.

Schools were chosen for conducting the study as it ensured better follow up of children. Many school based studies have revealed that if children are educated about the need to practise a healthy diet and exercise routine in their schools, they most probably tend to make healthier choices and have reduced number of risk factors for obesity [67, 68]. Schools have been recognized as the perfect spaces to administer intervention strategies because of their impact on the family and society.

Anthropometry

350 obese/overweight children were recruited to this study. The incidence of obesity was found to be more in the 11-12 years age group in this study which is similar to a study conducted in neighbouring Pondicherry by Mahajan, et al [69] which showed a higher prevalence of obesity in the age of 11 years. The body weight and body mass index were found to be higher in female gender than male in this study in all age group. This finding was in concordance to that reported from other studies done by Subramanian, et al [51], Shabana, et al [50] and Laxmaiah, et al [52] which reported higher prevalence of obesity /overweight in female

gender. Females have a greater preponderance to been overweight compared to males owing to their inherent hormonal differences.

Family history of obesity

5.7% of the children in this study had a family history of obesity. Parental obesity is a strong predictor. Adopted children resembling their biological parents than their adopted ones provide strong evidence for the genetic influence on their BMI. Resting energy expenditure and basic metabolic rate are inherited. Even cultural aspects also play a role as it determines their dietary practices and physical activity.

Co morbid conditions

In this study children and parents were enquired about symptoms suggestive of any co morbid condition. Breathlessness and wheezing was reported in 8.9% and 33.4% of the children respectively; this could be attributed to asthma. Obesity predispose to asthma due to the decreased chest wall compliance, decreased lung capacity and functional residual capacity. 9.2% of the children had sleep disturbances in the form of snoring. Vague abdominal pain was reported in 17.7% of children, while heart burns in another 21% which could probably be due to gastroesophageal reflux and gallstones in rarer cases.

Baseline activity

This study found that only 16.3% of the obese/overweight children had recommended level of moderate physical activity. 83.7% of the children had their daily physical activity lasting less than an hour. Only 54.5% of obese adolescents were participating in outdoor games in a study done in Andhrapradesh [53]. While Subramanian, *et al* [51] showed that only 30 % of the overweight and obese children were engaged in at least 60 minutes of daily physical activity. Nearly 92% of the children in the age of 7-8 years were found to be sedentary in this study, while it was 84% in the 9-10 years old and 80 % in the 11-12 year old children. Laxmaiah, et al [52] found that nearly 45% of adolescents did not have enough physical activity. The prevalence of overweight and obesity (3.1%) was significantly lower among the adolescents who participated in outdoor games ($p < 0.004$) in the above mentioned study. The 2003 Youth Risk Behaviour Surveillance Study and the 2002 Youth Media Campaign Longitudinal Survey [43] found that 44.5% of the adolescent reported no moderate or vigorous physical activity while it was 61.5% of younger children (9–12 years of age).

About 86% of the children were engaged in TV watching for more than 1 hour per day in our study. The maximum incidence was found among the 7-8 year old children. A 2008 meta-analysis found 63 of 73 studies (86%) showed an increased rate of childhood obesity with

increased media exposure, with rates increasing proportionally to time spent watching television [70]. According to Ruangdaraganon, et al [71], the risk of being overweight increases proportionate to duration spent on television viewing. The risk of being overweight among adolescents who were sedentary, watching television ≥3 hrs/day, was considerably more (10.4%) compared with those who watched 0 or <3 hrs/day (5.9% to 6.3%) according to Laxmaiah, et al [52]. Shabana, et al [50] showed watching television for more than 2 hours daily increased the odds ratio of being overweight [OR(95%CI)=2.5(1.1-5.4)] compared to children who watched television occasionally ($p<0.0001$). 87% of the adolescents were reportedly watching TV on school days for more than an hour a day [43]. The association of weight gain and obesity is likely due to the reduced physical activity in view of invasion of television during play time and to increased consumption of junk foods and beverages high in calories, which are advertised on television.

Dietary practices

Nearly 89% of the obese/overweight children consumed calories in excess than recommended for their age and gender in this study. According to another study, the prevalence of overweight and obesity was significantly higher among the adolescents, who had intakes of calorie ≥70% of RDA as compared to <70% of RDA [43]. The average

calorie intake of the obese children was 2341.98 kilocalories (S.D=228.29) and 2253.39 kilocalories (S.D=267.90) for the overweight children in this study. Aziz, et al [72] found that the average calorie intake to be 1861.3±849 kcal per day for overweight children and for obese it was 2056.7±895 kcal per day.

About 44.6% of the children in our study skipped breakfast for more 5 days a week. 16.0% of the obese group skipped breakfast daily according to Soo, et al [8]. 15.3% of the adolescents did not eat breakfast, they were 1.5 times more likely to be overweight than those who usually ate breakfast [43]. Keski-Rahkonen, *et al* [56] have shown in their study that children and adolescents who skipped breakfast have higher BMI and an increased risk of obesity compared to those who took breakfast regularly. The possible explanation to this may be related to increased calorie intake and snacking during the day when breakfast was not consumed.

The consumption of junk food on more occasions per week was present in about 75.7% of the obese/overweight children in our study. According to Laxmaiah, et al [52], 22% of adolescents consume junk foods and the prevalence of obesity was higher among those who consumed junk foods (12.6%; 95% CI: 8.6, 16.6). The frequency of intake of fast foods such as fried items, pizzas, burgers and noodles was significantly ($p < 0.05$) higher among the obese population [43]. An increase in

consumption of sweetened beverages by at least one serving per day was found to be associated with an increased risk of obesity [73]. Sugar sweetened beverages contribute extensively to the consumption of calories in excess as the calories in fluid form are poorly regulated by the body. *Besides the* sugar in these drinks adds to the dietary glycemic load, which exacerbate the metabolic syndrome and is related to the risk of developing diabetes mellitus in the children.The overwhelming impact of the sedentary lifestyle and dietary practices on the prevalence of obesity is well established and there is a need to intervene at the earliest to curb this unhealthy lifestyle practices among children.

Activity of the child –post intervention

The purpose for augmenting the physical activity was to maintain healthy body weight. The recommendation is one hour of moderate-intensity physical activity, such as walking, cycling, jogging etc. The moderate intensity physical activity is one where the person is breathing at a faster rate but able to converse without any difficulty. This level of physical activity is needed to maintain a healthy body weight, especially for people with sedentary lifestyle. The recommendation is based on calculations of energy balance and on an analysis of the extensive literature on the relationships between body weight and physical activity. In this study about 54.4% of the obese/overweight children observed the

recommended one hour of physical activity following the intervention. 38.1% of the children who earlier had negligible physical activity improved their physical activity to an hour following the intervention in them. Significant improvement in the physical activity was by children belonging to 9-10 years age group. The RESCATE [63] study in Mexico showed an increase in the performance of physical activity among children who had not performed any physical activity at baseline any day of the week (40%, $P = 0.04$) at end of follow up at 1 year. The average time spent by the children in moderate physical activity after the intervention was 61.66 minutes in this study. CATCH [64] intervention reported significantly more daily vigorous activity in cases than controls (58.6 minutes vs. 46.5 minutes; $p<0.003$). Physical activity has shown to decrease the insulin resistance in overweight children independent of changes in body weight or composition [54]. A recent study by Balagopal, et al [74] showed a decrease in weight gain and improvement of inflammatory markers in obese youth who participated in a 3-month exercise program. The activities recommended should be realistic and individualised according to the person's need. The need to burn out the calories they consume should be emphasized upon them.

The children who watched television for more than an hour a day plummeted to 38.2% from a whopping 86% following the intervention in

our study. Robinson et al [59] showed decrease in weight gain with decrease in time spent on television watching. The decrease in television viewing (by approximately 30 min/day) was very much significant for both boys and girls. , it seems that reduced eating in front of the television is at least as important as increasing activity was shown by the above study. The duration of television watching is linked with increased incidence of obesity among children and with a higher preponderance to type 2 diabetes and gallstones. This possibility is likely due to the reduced physical activity as a result of invasion of playtime by television and to the increased consumption of junk foods and beverages which are rich in calories and poor in nutrients, which are typically marketed on television.

The time spent by the children on sedentary games indoor has also decreased significantly in this study. It tumbled to 4.7% of the children from the initial 14.3% who indulged in excess in these sedentary pursuits. RESCATE study [63] also showed a noteworthy decrease in the number of children who spent more than 3 hours a day playing video games (from 23 to 13%, $p = 0.01$) following intervention. Children belonging to 11-12 years showed maximum improvement in deduction of the sedentary activity (66.4%) in our study.

Dietary practices-post intervention

Pignone, et al showed that dietary counselling by doctors pointed out that even brief information about nutrition aspects to children can drastically influence their behaviour and that the magnitude of the effect is related to the strength of the intervention [61]. About 69.8 % of the children consumed calories appropriate to their age and gender; they have improved on their intake of fruits and vegetables at end of 1 year. The average calorie intake decreased by about 321.49 kcal/day among the obese and overweight children. Dietary intervention study by Rolland et al [75] showed a compliance of 69% among children at 1 year of follow up, 59% at the end of 2 years. Armador, et al [76] showed 83% compliance for dietary intervention at the end of 1 year of follow up while Ebbeling et al [77] showed a compliance of 88%.

After the intervention nearly 83% of the children had breakfast on most days of the week; with an improvement seen in nearly 27% of the children. The consumption of the junk food has found to have decreased dramatically from 75.7% of the children to 37.6% following the intervention. James et al [65] showed significant decrease in the incidence of obesity after one year among 7-11 year old children who received intervention to decrease the consumption of sweeten beverages. The proportion of children who consumed snacks during TV watching decreased from 65.1% to 34.9% of the study population.

The improvement in dietary practices was observed maximally by children in the age group of 9-10 years. Thomas, et al [62] found the highest likelihood to reduce overweight was found in children younger than 12 years, this underlines the necessity of an early intervention in childhood obesity which has been reinforced by this study.

Significant change in body mass index was observed in the children following intervention was observed in the study (p=0-000). Yedavdekar rajiv, et al showed that BMI was significantly reduced among interventional group i.e. overweight & obese boys & girls ($p < 0.05$ and $p < 0.01$ respectively)[67] in a school based intervention study. Robinson, et al [59] showed a reduction in obesity prevalence in girls (OR = 0.47; 95%CI: 0.24 – 0.93), but not in boys (OR = 0.85; 95%CI: 0.52 – 1.39) in whom lifestyle intervention were given. The Planet health intervention [60] showed a significant reduction in obesity among the study group (AOR 2.16, 95% CI 1.07 to 4.35).

With the above observation, we can conclude that intervention was able to increase the physical activity and reduce the time spent on sedentary pursuits and follow healthy diet. In the study by Mara et al [57], 63% (girls) and 77% (boys) in a Brazil completed 6 months of a lifestyle intervention therapy with more than 75% compliance in both physical activity and nutritional aspects which is almost similar to compliance

obtained in our study. Our study found a compliance of 55% in increasing physical activity, 77% compliance in reduction of sedentary activities and 70% compliance in healthy dietary habits.

CONCLUSION

- The study showed the presence of overweight and obesity in children belonging to lower socioeconomic status against the common misconception.

- The children and parents were made to imbibe the adverse consequence of being overweight and the role of the unhealthy lifestyle in them being overweight.

- The children and parents enrolled in the study were convinced about the need to bring about changes in their lifestyle.

- However the knowledge was not converted to action in cent percent of the children as the study showed a compliance ranging from 60 to 70 % for various aspects of lifestyle changes in the children.

- The modification has resulted in significant decrease in BMI among the study population.

- The compliance for the lifestyle changes must be observed however for a much longer period to know the ultimate outcome of such measures.

RECOMMENDATIONS

- Lifestyle modification is the key aspect in the prevention and as well as management of obesity.

- Lifestyle modifications results in significant reduction in the risk factors associated with obesity and the associated co morbidities and help to prevent future obesity.

- Compliance over a long term basis is the key factor in the outcome of lifestyle modifications as otherwise there is regain of the lost weight.

STUDY LIMITATIONS

The follow up was done only for a year in this study for the lifestyle practices in the obese / overweight children. However the

compliance for the lifestyle changes must be observed for a much longer period to know the ultimate outcome of such measures

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Annexure

INITIAL VISIT DATA FORM

Date: _____

IDNo:_____

1. Name : -

_____

Age :

_____

Sex :

_____

2. School :

_____

Class :

_____

3. Residential Address :

_____

& Phone No.

_____

4. <u>Physical Examination</u>

a. Height :

_____cm

b. Weight :

_____ kg

c. BMI :

kg/m^2

d. Vitals : HR_____RR_____BP_

e. Head to Foot Examination :

_____

Eyes :

_____

Oral Cavity :

_____

Neck :

_____

Musculoskeletal :

_____

System

f. System Examination :

_____

Cardiovascular :

_____ _____

Respiratory : _____

Abdomen : _____

Central Nervous : _____

System

5.ASSESSMENT

Normal Weight □ BMI 5-84th percentile for age & gender

Blood sugar

T3

T4

TSH

Serum cholesterol

Serum triglyceride

Over Weight □ BMI 85-94th percentile for age & gender

Obese □ BMI >=95th percentile for age & gender

ANNEXURE

LABORATORY DATA FORM

Name

Age

Sex

ID No

Reports

Blood sugar

Serum cholesterol

Serum triglyceride

Serum TSH

PARENT - CHILD QUESTIONNAIRE

FORM ID NO

1. Name
2. Age
3. Sex
4. School
5. Class
6. Accompanied by
7. Residential Address
8. Assessment of BMI of family members (Multiple sittings)
9. a) Father
   b) Mother

10. Family History

a) Diabetes mellitus	Yes / No / Not Known
b) Hypertension	Yes / No / Not Known
c) Coronary heart disease	Yes / No / Not Known
d) Thyroid Disorders	Yes / No / Not Known
e) Stroke	Yes / No / Not Known

11. Symptoms in child

a) Chest pain	Yes / No
b) Breathlessness	Yes / No
c) Wheezing	Yes / No
d) Abdominal Pain	Yes / No
e) Heart Burns	Yes / No
f) Sleep Disturbances	Yes / No
g) Eating Disorders	Yes / No

12 . Current Lifestyle Habits (i)

Activity

a) What type of physical work your child normally involves in?

Outdoor games : Yes/No ; duration - hrs

Walking to School : Yes/No ; duration - hrs

Walking to Shop : Yes/No ; duration - hrs

Climbing Staircase : Yes/No ; duration - hrs

Dance : Yes/No ; duration - hrs

Martial Arts class : Yes/No; duration - hrs

b) Does your child feel fatigue after

Normal daily activities : Yes/No

Walking for short distance : Yes/No

Climbing staircase(2 flights) : Yes/No

An hour of play : Yes/No

c) How long she/he spend viewing TV daily (in hrs)?

d) How long she/he spend time on computers daily (in hrs)?

e) How long do parents spend time on TV viewing daily (in hrs)?

f) Does your child watch TV under your supervision? Yes/no

g) Does she/he eat snacks during computer/TV viewing? Yes/no

h) What remains an obstacle to active play? (to be coded later)

Lack of interest

Lack of energy

Attraction to TV/computers Tuitions

Lack of convenient place

Extra curricular activities

Indoor games

ANNEXURE

Name Age Sex Class ...contd page 3

(ii) NUTRITION ID No.

a) Average calorie intake based on child's 3 day's meal?

Month: Year: Signature of Parent / Guardian

Pay 1	Day 2	Day 3

Average calorie intake :_____

b) Calorie in excess :

c) Does your child have break-fast daily?Yes/No

d) Does your child have the habit of eating snacks :

Friums	yes / no
Bajji	yes / no
Bonda	yes / no
Vadai	yes / no
Savories	yes / no
Candy	yes / no
Burfy	yes / no
Sarbat	yes / no

13.Consent to participate in study Yes/No

14. Counseling given

Signature of Investigator

Questions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Did your child involve in active physical work? How long (In hours)?																															
How many hours spent in front of T.V.?																															
How many hours spent on Computers?																															
Did he / she take snacks during T.V. Viewing?																															
Did he / she take snacks during Computer Games / Work?																															
Did he / she have breakfast today?																															
Did he / she stick to meal plan?																															
Did he / she take junk food today? If yes specify.																															

Njfepiy tphpT gbtk; - 3

ngah; : taJ : ghypdk; : tFg;G : milahs vz;.

nihptpj;jth; ngah; :

khjk; : tUlk; : ngw;Nwhh; / fhg;ghsh; ifnahg;gk;

Nfs;tpfs;	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
gq;fs; Foe;ij jPtpu clw;gapw;rpapy; <Lgl;lhuh? vt;tsT Neuk; ? (kzpapy;)																															
nihiyf;fhl;rp Kd;G vt;tsT Neuk; nrytopj;jhh;?																															
fzpzp Kd;G vt;tsT Neuk; nrytopj;jhh;?																															
mth; / mts; nihiyf;fhl;rp ghh;f;Fk; NghJ nehWf;Fj; jPdp rhg;gpl;lhuh?																															
mth; / mts; ,d;W fhiy rpw;Wz;b cz;lhuh?																															
mth; / mts; kUj;Jthpd; MNyhridg;gb cz;lhuh?																															
mth; / mts; ,d;W nfhOg;Gr;rj;J czT cz;lhuh? cz;lhh; vd;why; vd;d czT?																															

ANNEXURE

FOLLOW UP QUESTIONNAIRE FORM 4

ID NO.

1. Name
2. age
3. Sex
4. School Class
5. Accompanied by
6. Spread sheet compiled by
7. How your child reacted to the changes? cooperative/ reluctant

8. Average calorie intake based on 3 day meal :

ASSESSMENT

- Examination

Height	cm.
Weight	kg-
BM1	Kg/m^2

- Improvement since last visit

Nutrition	yes / no
Activity	yes / no

PLAN

COUNSELLING / REINFORCEMENT

Nutrition

Activity

Signature of investigator

ANNEXURE

PARENT'S INFORMATION SHEET

- Your child is obese/overweight for his / her age and gender.
- The obesity in childhood is likely to persist into adulthood.
- They are at potential risk for Diabetes mellitus, Hypertension, Dyslipidemia, Coronary artery disease, Arthritis etc.
- Modifications in your child's activity and nutrition are necessary to reduce his / her body weight.
- It is necessary to inculcate healthy lifestyle changes in childhood itself as it is difficult to bring about the changes in later years.
- The modifications in his / her activity and nutrition will go a long way in preventing obesity in later years with all its attendant health risks.

ngw;Nwhhpd; jfty; gbtk;

gFjp - II - m

- cq;fs; Foe;ijapd; cly; vil tajpw;F mjpfkhd mstpy; cs;sJ.

- rpWtajpy; cly;gUkd; Neha; te;jhy; ngUk;ghYk; tajhd gpwFk; me;j Neha; njhlh;tjw;fhd tha;g;G cs;sJ.

- cly; gUkd; Nehapdhy; ePhpopT Neha;> uj;j nfhjpg;G> ,ja Neha;> %l;Ltyp kw;Wk; gpw Neha;fs; tUtjw;fhd mghak; cs;sJ.

- jq;fs; Foe;ijapd; cly; vilia Fiwf;f jPtpu clw;gapw;rp kw;Wk; rhpahd czT gof;fq;fis filgpbf;f Ntz;Lk;.

- rpWtaJ KjNy Njfepiy kw;Wk; rhpahd tho;f;if eilKiw gof;fq;fis Nkw;nfhs;s Ntz;Lk;. ,y;iynad;why; tajhd gpwF eilKiwgLj;Jjy; fbdkhFk;.

- Njfepiy kw;Wk; tho;f;if eilKiw gof;fq;fis Kiwahf filg;gpbj;jhy; gpw;fhyj;jpy; cly;gUkd; Neha; kw;Wk; mjdhy; tUk; kw;w Neha;fis fl;Lg;gLj;Jk;.

ANNEXURE

INFORMED CONSENT FORM

- I understand the risks faced by my child in being obese / overweight and the need to collect and investigate blood samples from my child as told by the investigator.
- I confirm that I have been told about this .study in my mother tongue and have had the opportunity to ask questions. I confirm that I have been told about the risks and potential benefits for my child's participation in the study. I agree to give my concent for the participation of my child in this study.
- I understand that my consent for my child's participation in the study is voluntary and I can withdraw my child from participating in the study at any time without giving any reason.
- I agree not to restrict the use of any data or results that arise from this study.

Name of the Child :_____

Name of the Parent / Guardian :_____

Signature of the Parent / Guardian :_____

Date :

Thumb print of illiterate parent / guardian

Name of the Witness : Signature of the Witness : Date :

Name of the Investigator / Medical Officer : Signature of the investigator / Medical Officer :

Date- :

ngw;Nwhhpd; jfty; gbtk;

gFjp - II – M

- vdJ Foe;ijf;F cly;gUkd; Neha; cs;sJ vd;W kUj;Jtuhy; njhptpf;fg;gl;lJ. mjdhy; vd; Foe;ijapd; uj;jk; ghpNrhjid nra;tJ mtrpak; vd;gJ njhptpf;fg;gl;lJ.
- ,e;j Ma;T gw;wp vdf;F tpsf;fkhf vdJ jha;nkhopapy; (jkpo;) nrhy;yg;gl;lJ. ,e;j Ma;tpy; gq;nfLj;Jf; nfhs;tjhy; vdJ Foe;ijf;F Vw;glf;$ba mghaq;fs; kw;Wk; ed;ikfs; gw;wp tpsf;fg;gl;lJ. ,e;j Ma;tpy; gq;nfLj;Jf; nfhs;s KOkdJld; rk;kjpf;fpNwd;. Nfs;tpfs; Nfl;gjw;F vdf;F tha;g;G mspf;fg;gl;lJ.
- ,e;j Ma;tpy; gq;Nfw;gJ jd;dpr;irahdJ. ve;j Neuj;jpYk; vd; Foe;ij gq;Nfw;gij vt;tpj tpsf;fKk; ngwhky; epWj;jpf; nfhs;syhk;.
- ,e;j Ma;tpypUe;J fpilf;Fk; KbTfis gad;gLj;Jtij fl;Lg;gLj;jhkypUf;f ehd; rk;kjpf;fpNwd;.

Foe;ijapd; ngah; .....

Foe;ijapd; ngw;Nwhh;/ .....
fz;fhzpg;ghsh; ngah;

Foe;ijapd; ngw;Nwhh;/ .....
fz;fhzpg;ghsh; ifnaOj;J

Njjp: .....

vOjg; gbf;fj; njhpahj ngw;Nwhh; / fz;fhzpg;ghsh; if fl;ltpuy; Nuif:

rhl;rpapd; ngah; .....

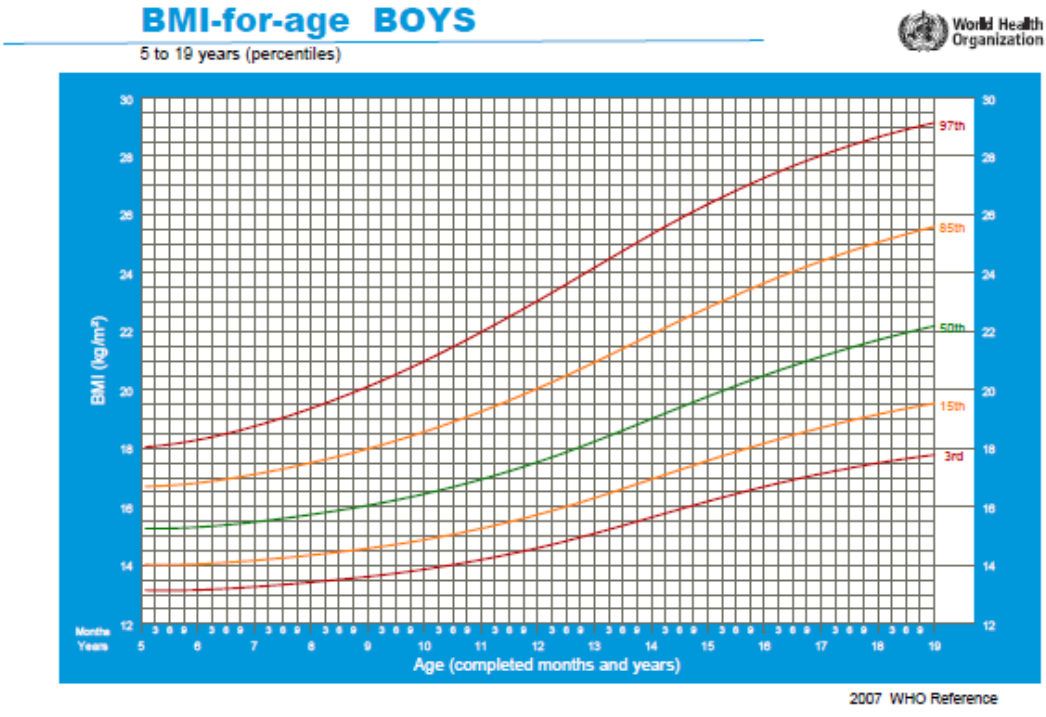
rhl;rpapd; ifnaOj;J.....

Njjp .....

Ma;thsh;/ Ma;T kUj;Jth; ngah; :.....

Ma;thsh;/Ma;T kUj;Jth; :.....
ifnaOj;J

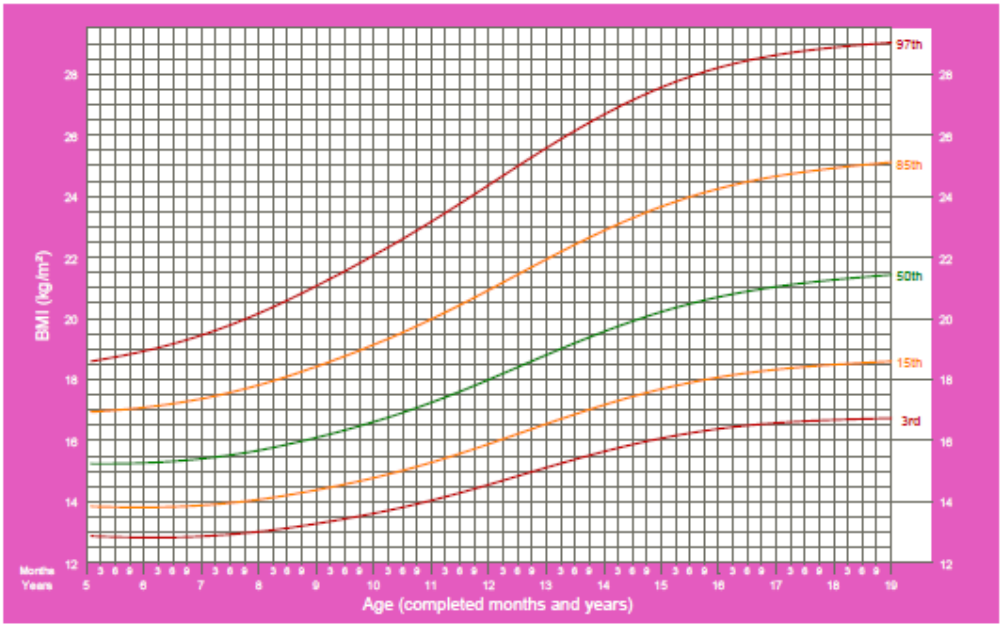
Njjp ...



BMI-for-age GIRLS

5 to 19 years (percentiles)

World Health Organization



2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)										
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
5: 1	61	-0.7387	15.2641	0.08390	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.1	18.8
5: 2	62	-0.7621	15.2616	0.08414	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.1	18.9
5: 3	63	-0.7856	15.2604	0.08439	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.1	18.9
5: 4	64	-0.8089	15.2605	0.08464	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.1	18.9
5: 5	65	-0.8322	15.2619	0.08490	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.1	18.9
5: 6	66	-0.8554	15.2645	0.08516	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.1	19.0
5: 7	67	-0.8785	15.2684	0.08543	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.7	17.7	18.2	19.0
5: 8	68	-0.9015	15.2737	0.08570	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.8	17.8	18.2	19.0
5: 9	69	-0.9243	15.2801	0.08597	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.8	17.8	18.2	19.1
5:10	70	-0.9471	15.2877	0.08625	12.7	13.1	13.4	14.0	14.4	15.3	16.2	16.8	17.8	18.2	19.1
5:11	71	-0.9697	15.2965	0.08653	12.7	13.2	13.4	14.0	14.5	15.3	16.2	16.8	17.8	18.3	19.1
6: 0	72	-0.9921	15.3062	0.08682	12.7	13.2	13.4	14.0	14.5	15.3	16.3	16.8	17.9	18.3	19.2
6: 1	73	-1.0144	15.3169	0.08711	12.7	13.2	13.4	14.0	14.5	15.3	16.3	16.8	17.9	18.3	19.2
6: 2	74	-1.0365	15.3285	0.08741	12.7	13.2	13.4	14.1	14.5	15.3	16.3	16.9	17.9	18.4	19.3
6: 3	75	-1.0584	15.3408	0.08771	12.8	13.2	13.4	14.1	14.5	15.3	16.3	16.9	17.9	18.4	19.3
6: 4	76	-1.0801	15.3540	0.08802	12.8	13.2	13.4	14.1	14.5	15.4	16.3	16.9	18.0	18.4	19.4
6: 5	77	-1.1017	15.3679	0.08833	12.8	13.2	13.4	14.1	14.5	15.4	16.3	16.9	18.0	18.5	19.4
6: 6	78	-1.1230	15.3825	0.08865	12.8	13.2	13.4	14.1	14.5	15.4	16.4	16.9	18.0	18.5	19.4
6: 7	79	-1.1441	15.3978	0.08898	12.8	13.2	13.4	14.1	14.5	15.4	16.4	17.0	18.1	18.5	19.5
6: 8	80	-1.1649	15.4137	0.08931	12.8	13.2	13.5	14.1	14.5	15.4	16.4	17.0	18.1	18.6	19.6
6: 9	81	-1.1856	15.4302	0.08964	12.8	13.2	13.5	14.1	14.6	15.4	16.4	17.0	18.1	18.6	19.6
6:10	82	-1.2060	15.4473	0.08998	12.8	13.2	13.5	14.1	14.6	15.4	16.5	17.1	18.2	18.7	19.7
6:11	83	-1.2261	15.4650	0.09033	12.8	13.3	13.5	14.2	14.6	15.5	16.5	17.1	18.2	18.7	19.7
7: 0	84	-1.2460	15.4832	0.09068	12.8	13.3	13.5	14.2	14.6	15.5	16.5	17.1	18.3	18.8	19.8
7: 1	85	-1.2656	15.5019	0.09103	12.9	13.3	13.5	14.2	14.6	15.5	16.5	17.1	18.3	18.8	19.8
7: 2	86	-1.2849	15.5210	0.09139	12.9	13.3	13.5	14.2	14.6	15.5	16.6	17.2	18.3	18.8	19.9

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)									
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
7: 3	87	-1.3040	15.5407	0.09176	12.9	13.3	13.5	14.2	14.6	15.5	16.6	17.2	18.4	18.9	20.0
7: 4	88	-1.3228	15.5608	0.09213	12.9	13.3	13.6	14.2	14.7	15.6	16.6	17.2	18.4	18.9	20.0
7: 5	89	-1.3414	15.5814	0.09251	12.9	13.3	13.6	14.2	14.7	15.6	16.6	17.3	18.5	19.0	20.1
7: 6	90	-1.3596	15.6023	0.09289	12.9	13.3	13.6	14.3	14.7	15.6	16.7	17.3	18.5	19.0	20.2
7: 7	91	-1.3776	15.6237	0.09327	12.9	13.4	13.6	14.3	14.7	15.6	16.7	17.3	18.6	19.1	20.2
7: 8	92	-1.3953	15.6455	0.09366	12.9	13.4	13.6	14.3	14.7	15.6	16.7	17.4	18.6	19.2	20.3
7: 9	93	-1.4126	15.6677	0.09406	12.9	13.4	13.6	14.3	14.7	15.7	16.7	17.4	18.7	19.2	20.4
7:10	94	-1.4297	15.6903	0.09445	13.0	13.4	13.6	14.3	14.8	15.7	16.8	17.4	18.7	19.3	20.4
7:11	95	-1.4464	15.7133	0.09486	13.0	13.4	13.7	14.3	14.8	15.7	16.8	17.5	18.8	19.3	20.5
8: 0	96	-1.4629	15.7368	0.09526	13.0	13.4	13.7	14.4	14.8	15.7	16.8	17.5	18.8	19.4	20.6
8: 1	97	-1.4790	15.7606	0.09567	13.0	13.4	13.7	14.4	14.8	15.8	16.9	17.5	18.9	19.4	20.6
8: 2	98	-1.4947	15.7848	0.09609	13.0	13.5	13.7	14.4	14.8	15.8	16.9	17.6	18.9	19.5	20.7
8: 3	99	-1.5101	15.8094	0.09651	13.0	13.5	13.7	14.4	14.9	15.8	16.9	17.6	19.0	19.5	20.8
8: 4	100	-1.5252	15.8344	0.09693	13.0	13.5	13.7	14.4	14.9	15.8	17.0	17.7	19.0	19.6	20.9
8: 5	101	-1.5399	15.8597	0.09735	13.1	13.5	13.7	14.4	14.9	15.9	17.0	17.7	19.1	19.7	21.0
8: 6	102	-1.5542	15.8855	0.09778	13.1	13.5	13.8	14.5	14.9	15.9	17.0	17.7	19.1	19.7	21.0
8: 7	103	-1.5681	15.9116	0.09821	13.1	13.5	13.8	14.5	14.9	15.9	17.1	17.8	19.2	19.8	21.1
8: 8	104	-1.5817	15.9381	0.09864	13.1	13.5	13.8	14.5	15.0	15.9	17.1	17.8	19.2	19.9	21.2
8: 9	105	-1.5948	15.9651	0.09907	13.1	13.6	13.8	14.5	15.0	16.0	17.1	17.9	19.3	19.9	21.3
8:10	106	-1.6076	15.9925	0.09951	13.1	13.6	13.8	14.5	15.0	16.0	17.2	17.9	19.3	20.0	21.4
8:11	107	-1.6199	16.0205	0.09994	13.2	13.6	13.8	14.6	15.0	16.0	17.2	17.9	19.4	20.0	21.4
9: 0	108	-1.6318	16.0490	0.10038	13.2	13.6	13.9	14.6	15.1	16.0	17.2	18.0	19.5	20.1	21.5
9: 1	109	-1.6433	16.0781	0.10082	13.2	13.6	13.9	14.6	15.1	16.1	17.3	18.0	19.5	20.2	21.6
9: 2	110	-1.6544	16.1078	0.10126	13.2	13.7	13.9	14.6	15.1	16.1	17.3	18.1	19.6	20.2	21.7
9: 3	111	-1.6651	16.1381	0.10170	13.2	13.7	13.9	14.6	15.1	16.1	17.4	18.1	19.6	20.3	21.8

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)										
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
9: 4	112	-1.6753	16.1692	0.10214	13.2	13.7	13.9	14.7	15.1	16.2	17.4	18.2	19.7	20.4	21.9
9: 5	113	-1.6851	16.2009	0.10259	13.3	13.7	14.0	14.7	15.2	16.2	17.4	18.2	19.8	20.5	22.0
9: 6	114	-1.6944	16.2333	0.10303	13.3	13.7	14.0	14.7	15.2	16.2	17.5	18.3	19.8	20.5	22.1
9: 7	115	-1.7032	16.2665	0.10347	13.3	13.8	14.0	14.7	15.2	16.3	17.5	18.3	19.9	20.6	22.2
9: 8	116	-1.7116	16.3004	0.10391	13.3	13.8	14.0	14.8	15.3	16.3	17.6	18.4	20.0	20.7	22.3
9: 9	117	-1.7196	16.3351	0.10435	13.3	13.8	14.1	14.8	15.3	16.3	17.6	18.4	20.0	20.8	22.4
9:10	118	-1.7271	16.3704	0.10478	13.4	13.8	14.1	14.8	15.3	16.4	17.7	18.5	20.1	20.8	22.5
9:11	119	-1.7341	16.4065	0.10522	13.4	13.8	14.1	14.8	15.3	16.4	17.7	18.5	20.2	20.9	22.6
10: 0	120	-1.7407	16.4433	0.10566	13.4	13.9	14.1	14.9	15.4	16.4	17.7	18.6	20.2	21.0	22.7
10: 1	121	-1.7468	16.4807	0.10609	13.4	13.9	14.2	14.9	15.4	16.5	17.8	18.6	20.3	21.1	22.8
10: 2	122	-1.7525	16.5189	0.10652	13.4	13.9	14.2	14.9	15.4	16.5	17.8	18.7	20.4	21.1	22.9
10: 3	123	-1.7578	16.5578	0.10695	13.5	13.9	14.2	15.0	15.5	16.6	17.9	18.7	20.4	21.2	23.0
10: 4	124	-1.7626	16.5974	0.10738	13.5	14.0	14.2	15.0	15.5	16.6	17.9	18.8	20.5	21.3	23.1
10: 5	125	-1.7670	16.6376	0.10780	13.5	14.0	14.3	15.0	15.5	16.6	18.0	18.8	20.6	21.4	23.2
10: 6	126	-1.7710	16.6786	0.10823	13.5	14.0	14.3	15.1	15.6	16.7	18.0	18.9	20.7	21.5	23.3
10: 7	127	-1.7745	16.7203	0.10865	13.6	14.0	14.3	15.1	15.6	16.7	18.1	19.0	20.7	21.6	23.4
10: 8	128	-1.7777	16.7628	0.10906	13.6	14.1	14.3	15.1	15.6	16.8	18.1	19.0	20.8	21.6	23.5
10: 9	129	-1.7804	16.8059	0.10948	13.6	14.1	14.4	15.2	15.7	16.8	18.2	19.1	20.9	21.7	23.6
10:10	130	-1.7828	16.8497	0.10989	13.6	14.1	14.4	15.2	15.7	16.9	18.2	19.1	21.0	21.8	23.7
10:11	131	-1.7847	16.8941	0.11030	13.7	14.2	14.4	15.2	15.8	16.9	18.3	19.2	21.0	21.9	23.8
11: 0	132	-1.7862	16.9392	0.11070	13.7	14.2	14.5	15.3	15.8	16.9	18.4	19.3	21.1	22.0	23.9
11: 1	133	-1.7873	16.9850	0.11110	13.7	14.2	14.5	15.3	15.8	17.0	18.4	19.3	21.2	22.1	24.0
11: 2	134	-1.7881	17.0314	0.11150	13.8	14.3	14.5	15.3	15.9	17.0	18.5	19.4	21.3	22.2	24.1
11: 3	135	-1.7884	17.0784	0.11189	13.8	14.3	14.6	15.4	15.9	17.1	18.5	19.4	21.4	22.2	24.2

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)										
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
11: 4	136	-1.7884	17.1262	0.11228	13.8	14.3	14.6	15.4	16.0	17.1	18.6	19.5	21.4	22.3	24.4
11: 5	137	-1.7880	17.1746	0.11266	13.9	14.4	14.6	15.4	16.0	17.2	18.6	19.6	21.5	22.4	24.5
11: 6	138	-1.7873	17.2236	0.11304	13.9	14.4	14.7	15.5	16.0	17.2	18.7	19.6	21.6	22.5	24.6
11: 7	139	-1.7861	17.2734	0.11342	13.9	14.4	14.7	15.5	16.1	17.3	18.8	19.7	21.7	22.6	24.7
11: 8	140	-1.7846	17.3240	0.11379	13.9	14.5	14.7	15.6	16.1	17.3	18.8	19.8	21.8	22.7	24.8
11: 9	141	-1.7828	17.3752	0.11415	14.0	14.5	14.8	15.6	16.2	17.4	18.9	19.8	21.8	22.8	24.9
11:10	142	-1.7806	17.4272	0.11451	14.0	14.5	14.8	15.6	16.2	17.4	18.9	19.9	21.9	22.9	25.0
11:11	143	-1.7780	17.4799	0.11487	14.0	14.6	14.9	15.7	16.3	17.5	19.0	20.0	22.0	23.0	25.1
12: 0	144	-1.7751	17.5334	0.11522	14.1	14.6	14.9	15.7	16.3	17.5	19.1	20.1	22.1	23.1	25.2
12: 1	145	-1.7719	17.5877	0.11556	14.1	14.6	14.9	15.8	16.3	17.6	19.1	20.1	22.2	23.1	25.3
12: 2	146	-1.7684	17.6427	0.11590	14.2	14.7	15.0	15.8	16.4	17.6	19.2	20.2	22.3	23.2	25.4
12: 3	147	-1.7645	17.6985	0.11623	14.2	14.7	15.0	15.9	16.4	17.7	19.3	20.3	22.3	23.3	25.6
12: 4	148	-1.7604	17.7551	0.11656	14.2	14.8	15.1	15.9	16.5	17.8	19.3	20.3	22.4	23.4	25.7
12: 5	149	-1.7559	17.8124	0.11688	14.3	14.8	15.1	16.0	16.5	17.8	19.4	20.4	22.5	23.5	25.8
12: 6	150	-1.7511	17.8704	0.11720	14.3	14.8	15.1	16.0	16.6	17.9	19.5	20.5	22.6	23.6	25.9
12: 7	151	-1.7461	17.9292	0.11751	14.3	14.9	15.2	16.1	16.6	17.9	19.5	20.6	22.7	23.7	26.0
12: 8	152	-1.7408	17.9887	0.11781	14.4	14.9	15.2	16.1	16.7	18.0	19.6	20.6	22.8	23.8	26.1
12: 9	153	-1.7352	18.0488	0.11811	14.4	15.0	15.3	16.2	16.8	18.0	19.7	20.7	22.9	23.9	26.2
12:10	154	-1.7293	18.1096	0.11841	14.5	15.0	15.3	16.2	16.8	18.1	19.7	20.8	23.0	24.0	26.3
12:11	155	-1.7232	18.1710	0.11869	14.5	15.0	15.4	16.3	16.9	18.2	19.8	20.9	23.1	24.1	26.4
13: 0	156	-1.7168	18.2330	0.11898	14.5	15.1	15.4	16.3	16.9	18.2	19.9	20.9	23.1	24.2	26.5
13: 1	157	-1.7102	18.2955	0.11925	14.6	15.1	15.4	16.4	17.0	18.3	19.9	21.0	23.2	24.3	26.7
13: 2	158	-1.7033	18.3586	0.11952	14.6	15.2	15.5	16.4	17.0	18.4	20.0	21.1	23.3	24.4	26.8
13: 3	159	-1.6962	18.4221	0.11979	14.7	15.2	15.5	16.5	17.1	18.4	20.1	21.2	23.4	24.5	26.9

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)										
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
5: 1	61	-0.8886	15.2441	0.09692	12.4	12.9	13.1	13.8	14.3	15.2	16.3	16.9	18.1	18.6	19.6
5: 2	62	-0.9068	15.2434	0.09738	12.4	12.9	13.1	13.8	14.3	15.2	16.3	16.9	18.1	18.6	19.6
5: 3	63	-0.9248	15.2433	0.09783	12.4	12.9	13.1	13.8	14.3	15.2	16.3	17.0	18.1	18.7	19.7
5: 4	64	-0.9427	15.2438	0.09829	12.4	12.9	13.1	13.8	14.3	15.2	16.3	17.0	18.2	18.7	19.7
5: 5	65	-0.9605	15.2448	0.09875	12.4	12.9	13.1	13.8	14.3	15.2	16.3	17.0	18.2	18.7	19.8
5: 6	66	-0.9780	15.2464	0.09920	12.4	12.8	13.1	13.8	14.3	15.2	16.3	17.0	18.2	18.7	19.8
5: 7	67	-0.9954	15.2487	0.09966	12.4	12.8	13.1	13.8	14.3	15.2	16.3	17.0	18.2	18.8	19.8
5: 8	68	-1.0126	15.2516	0.10012	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.0	18.3	18.8	19.9
5: 9	69	-1.0296	15.2551	0.10058	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.0	18.3	18.8	19.9
5:10	70	-1.0464	15.2592	0.10104	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.0	18.3	18.9	20.0
5:11	71	-1.0630	15.2641	0.10149	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.1	18.3	18.9	20.0
6: 0	72	-1.0794	15.2697	0.10195	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.1	18.4	18.9	20.1
6: 1	73	-1.0956	15.2760	0.10241	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.1	18.4	19.0	20.1
6: 2	74	-1.1115	15.2831	0.10287	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.1	18.4	19.0	20.2
6: 3	75	-1.1272	15.2911	0.10333	12.4	12.8	13.1	13.8	14.3	15.3	16.4	17.1	18.5	19.0	20.2
6: 4	76	-1.1427	15.2998	0.10379	12.4	12.8	13.1	13.8	14.3	15.3	16.5	17.2	18.5	19.1	20.3
6: 5	77	-1.1579	15.3095	0.10425	12.4	12.8	13.1	13.8	14.3	15.3	16.5	17.2	18.5	19.1	20.4
6: 6	78	-1.1728	15.3200	0.10471	12.4	12.8	13.1	13.8	14.3	15.3	16.5	17.2	18.6	19.2	20.4
6: 7	79	-1.1875	15.3314	0.10517	12.4	12.8	13.1	13.8	14.3	15.3	16.5	17.2	18.6	19.2	20.5
6: 8	80	-1.2019	15.3439	0.10562	12.4	12.8	13.1	13.8	14.3	15.3	16.5	17.3	18.6	19.3	20.5
6: 9	81	-1.2160	15.3572	0.10608	12.4	12.8	13.1	13.9	14.3	15.4	16.6	17.3	18.7	19.3	20.6
6:10	82	-1.2298	15.3717	0.10654	12.4	12.9	13.1	13.9	14.3	15.4	16.6	17.3	18.7	19.3	20.7
6:11	83	-1.2433	15.3871	0.10700	12.4	12.9	13.1	13.9	14.4	15.4	16.6	17.3	18.8	19.4	20.7
7: 0	84	-1.2565	15.4036	0.10746	12.4	12.9	13.1	13.9	14.4	15.4	16.6	17.4	18.8	19.4	20.8
7: 1	85	-1.2693	15.4211	0.10792	12.4	12.9	13.1	13.9	14.4	15.4	16.6	17.4	18.9	19.5	20.9
7: 2	86	-1.2819	15.4397	0.10837	12.4	12.9	13.2	13.9	14.4	15.4	16.7	17.4	18.9	19.6	20.9

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)									
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
7: 3	87	-1.2941	15.4593	0.10883	12.4	12.9	13.2	13.9	14.4	15.5	16.7	17.5	19.0	19.6	21.0
7: 4	88	-1.3060	15.4798	0.10929	12.4	12.9	13.2	13.9	14.4	15.5	16.7	17.5	19.0	19.7	21.1
7: 5	89	-1.3175	15.5014	0.10974	12.4	12.9	13.2	13.9	14.4	15.5	16.8	17.5	19.1	19.7	21.2
7: 6	90	-1.3287	15.5240	0.11020	12.5	12.9	13.2	14.0	14.5	15.5	16.8	17.6	19.1	19.8	21.2
7: 7	91	-1.3395	15.5476	0.11065	12.5	12.9	13.2	14.0	14.5	15.5	16.8	17.6	19.2	19.8	21.3
7: 8	92	-1.3499	15.5723	0.11110	12.5	13.0	13.2	14.0	14.5	15.6	16.9	17.6	19.2	19.9	21.4
7: 9	93	-1.3600	15.5979	0.11156	12.5	13.0	13.2	14.0	14.5	15.6	16.9	17.7	19.3	20.0	21.5
7:10	94	-1.3697	15.6246	0.11201	12.5	13.0	13.3	14.0	14.5	15.6	16.9	17.7	19.3	20.0	21.6
7:11	95	-1.3790	15.6523	0.11246	12.5	13.0	13.3	14.0	14.6	15.7	17.0	17.8	19.4	20.1	21.7
8: 0	96	-1.3880	15.6810	0.11291	12.5	13.0	13.3	14.1	14.6	15.7	17.0	17.8	19.4	20.2	21.7
8: 1	97	-1.3966	15.7107	0.11335	12.6	13.0	13.3	14.1	14.6	15.7	17.0	17.9	19.5	20.2	21.8
8: 2	98	-1.4047	15.7415	0.11380	12.6	13.1	13.3	14.1	14.6	15.7	17.1	17.9	19.6	20.3	21.9
8: 3	99	-1.4125	15.7732	0.11424	12.6	13.1	13.4	14.1	14.7	15.8	17.1	18.0	19.6	20.4	22.0
8: 4	100	-1.4199	15.8058	0.11469	12.6	13.1	13.4	14.2	14.7	15.8	17.2	18.0	19.7	20.4	22.1
8: 5	101	-1.4270	15.8394	0.11513	12.6	13.1	13.4	14.2	14.7	15.8	17.2	18.1	19.8	20.5	22.2
8: 6	102	-1.4336	15.8738	0.11557	12.6	13.1	13.4	14.2	14.7	15.9	17.2	18.1	19.8	20.6	22.3
8: 7	103	-1.4398	15.9090	0.11601	12.7	13.2	13.4	14.2	14.8	15.9	17.3	18.2	19.9	20.7	22.4
8: 8	104	-1.4456	15.9451	0.11644	12.7	13.2	13.5	14.3	14.8	15.9	17.3	18.2	20.0	20.7	22.5
8: 9	105	-1.4511	15.9818	0.11688	12.7	13.2	13.5	14.3	14.8	16.0	17.4	18.3	20.0	20.8	22.6
8:10	106	-1.4561	16.0194	0.11731	12.7	13.2	13.5	14.3	14.9	16.0	17.4	18.3	20.1	20.9	22.7
8:11	107	-1.4607	16.0575	0.11774	12.8	13.3	13.5	14.4	14.9	16.1	17.5	18.4	20.2	21.0	22.8
9: 0	108	-1.4650	16.0964	0.11816	12.8	13.3	13.6	14.4	14.9	16.1	17.5	18.4	20.2	21.1	22.9
9: 1	109	-1.4688	16.1358	0.11859	12.8	13.3	13.6	14.4	15.0	16.1	17.6	18.5	20.3	21.1	23.0
9: 2	110	-1.4723	16.1759	0.11901	12.8	13.3	13.6	14.4	15.0	16.2	17.6	18.5	20.4	21.2	23.1
9: 3	111	-1.4753	16.2166	0.11943	12.8	13.4	13.6	14.5	15.0	16.2	17.7	18.6	20.5	21.3	23.2

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)									
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
9: 4	112	-1.4780	16.2580	0.11985	12.9	13.4	13.7	14.5	15.1	16.3	17.7	18.7	20.5	21.4	23.3
9: 5	113	-1.4803	16.2999	0.12026	12.9	13.4	13.7	14.5	15.1	16.3	17.8	18.7	20.6	21.5	23.4
9: 6	114	-1.4823	16.3425	0.12067	12.9	13.4	13.7	14.6	15.1	16.3	17.8	18.8	20.7	21.6	23.5
9: 7	115	-1.4838	16.3858	0.12108	13.0	13.5	13.8	14.6	15.2	16.4	17.9	18.8	20.7	21.6	23.6
9: 8	116	-1.4850	16.4298	0.12148	13.0	13.5	13.8	14.6	15.2	16.4	17.9	18.9	20.8	21.7	23.7
9: 9	117	-1.4859	16.4746	0.12188	13.0	13.5	13.8	14.7	15.2	16.5	18.0	18.9	20.9	21.8	23.8
9:10	118	-1.4864	16.5200	0.12228	13.0	13.6	13.9	14.7	15.3	16.5	18.0	19.0	21.0	21.9	23.9
9:11	119	-1.4866	16.5663	0.12268	13.1	13.6	13.9	14.7	15.3	16.6	18.1	19.1	21.1	22.0	24.0
10: 0	120	-1.4864	16.6133	0.12307	13.1	13.6	13.9	14.8	15.4	16.6	18.2	19.1	21.1	22.1	24.1
10: 1	121	-1.4859	16.6612	0.12346	13.1	13.6	14.0	14.8	15.4	16.7	18.2	19.2	21.2	22.2	24.2
10: 2	122	-1.4851	16.7100	0.12384	13.1	13.7	14.0	14.9	15.4	16.7	18.3	19.3	21.3	22.2	24.3
10: 3	123	-1.4839	16.7595	0.12422	13.2	13.7	14.0	14.9	15.5	16.8	18.3	19.3	21.4	22.3	24.4
10: 4	124	-1.4825	16.8100	0.12460	13.2	13.7	14.1	14.9	15.5	16.8	18.4	19.4	21.5	22.4	24.6
10: 5	125	-1.4807	16.8614	0.12497	13.2	13.8	14.1	15.0	15.6	16.9	18.5	19.5	21.5	22.5	24.7
10: 6	126	-1.4787	16.9136	0.12534	13.3	13.8	14.1	15.0	15.6	16.9	18.5	19.5	21.6	22.6	24.8
10: 7	127	-1.4763	16.9667	0.12571	13.3	13.9	14.2	15.1	15.7	17.0	18.6	19.6	21.7	22.7	24.9
10: 8	128	-1.4737	17.0208	0.12607	13.3	13.9	14.2	15.1	15.7	17.0	18.6	19.7	21.8	22.8	25.0
10: 9	129	-1.4708	17.0757	0.12643	13.4	13.9	14.2	15.1	15.8	17.1	18.7	19.8	21.9	22.9	25.1
10:10	130	-1.4677	17.1316	0.12678	13.4	14.0	14.3	15.2	15.8	17.1	18.8	19.8	22.0	23.0	25.2
10:11	131	-1.4642	17.1883	0.12713	13.4	14.0	14.3	15.2	15.9	17.2	18.8	19.9	22.1	23.1	25.3
11: 0	132	-1.4606	17.2459	0.12748	13.5	14.0	14.4	15.3	15.9	17.2	18.9	20.0	22.2	23.2	25.4
11: 1	133	-1.4567	17.3044	0.12782	13.5	14.1	14.4	15.3	16.0	17.3	19.0	20.0	22.2	23.3	25.6
11: 2	134	-1.4526	17.3637	0.12816	13.6	14.1	14.4	15.4	16.0	17.4	19.0	20.1	22.3	23.4	25.7
11: 3	135	-1.4482	17.4238	0.12849	13.6	14.2	14.5	15.4	16.1	17.4	19.1	20.2	22.4	23.5	25.8

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (percentiles)

World Health Organization

Year: Month	Month	L	M	S	Percentiles (BMI in kg/m²)										
					1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
11: 4	136	-1.4436	17.4847	0.12882	13.6	14.2	14.5	15.5	16.1	17.5	19.2	20.3	22.5	23.6	25.9
11: 5	137	-1.4389	17.5464	0.12914	13.7	14.2	14.6	15.5	16.2	17.5	19.3	20.4	22.6	23.7	26.0
11: 6	138	-1.4339	17.6088	0.12946	13.7	14.3	14.6	15.6	16.2	17.6	19.3	20.4	22.7	23.8	26.1
11: 7	139	-1.4288	17.6719	0.12978	13.7	14.3	14.7	15.6	16.3	17.7	19.4	20.5	22.8	23.9	26.2
11: 8	140	-1.4235	17.7357	0.13009	13.8	14.4	14.7	15.7	16.3	17.7	19.5	20.6	22.9	24.0	26.4
11: 9	141	-1.4180	17.8001	0.13040	13.8	14.4	14.8	15.7	16.4	17.8	19.6	20.7	23.0	24.1	26.5
11:10	142	-1.4123	17.8651	0.13070	13.9	14.5	14.8	15.8	16.4	17.9	19.6	20.8	23.1	24.2	26.6
11:11	143	-1.4065	17.9306	0.13099	13.9	14.5	14.9	15.8	16.5	17.9	19.7	20.8	23.2	24.3	26.7
12: 0	144	-1.4006	17.9966	0.13129	14.0	14.6	14.9	15.9	16.6	18.0	19.8	20.9	23.3	24.4	26.8
12: 1	145	-1.3945	18.0630	0.13158	14.0	14.6	15.0	15.9	16.6	18.1	19.9	21.0	23.4	24.5	26.9
12: 2	146	-1.3883	18.1297	0.13186	14.0	14.7	15.0	16.0	16.7	18.1	19.9	21.1	23.5	24.6	27.0
12: 3	147	-1.3819	18.1967	0.13214	14.1	14.7	15.0	16.1	16.7	18.2	20.0	21.2	23.6	24.7	27.2
12: 4	148	-1.3755	18.2639	0.13241	14.1	14.7	15.1	16.1	16.8	18.3	20.1	21.3	23.7	24.8	27.3
12: 5	149	-1.3689	18.3312	0.13268	14.2	14.8	15.1	16.2	16.8	18.3	20.2	21.3	23.8	24.9	27.4
12: 6	150	-1.3621	18.3986	0.13295	14.2	14.8	15.2	16.2	16.9	18.4	20.2	21.4	23.9	25.0	27.5
12: 7	151	-1.3553	18.4660	0.13321	14.3	14.9	15.2	16.3	17.0	18.5	20.3	21.5	23.9	25.1	27.6
12: 8	152	-1.3483	18.5333	0.13347	14.3	14.9	15.3	16.3	17.0	18.5	20.4	21.6	24.0	25.2	27.7
12: 9	153	-1.3413	18.6006	0.13372	14.3	15.0	15.3	16.4	17.1	18.6	20.5	21.7	24.1	25.3	27.8
12:10	154	-1.3341	18.6677	0.13397	14.4	15.0	15.4	16.4	17.1	18.7	20.6	21.8	24.2	25.4	27.9
12:11	155	-1.3269	18.7346	0.13421	14.4	15.1	15.4	16.5	17.2	18.7	20.6	21.8	24.3	25.5	28.0
13: 0	156	-1.3195	18.8012	0.13445	14.5	15.1	15.5	16.5	17.3	18.8	20.7	21.9	24.4	25.6	28.1
13: 1	157	-1.3121	18.8675	0.13469	14.5	15.2	15.5	16.6	17.3	18.9	20.8	22.0	24.5	25.7	28.2
13: 2	158	-1.3046	18.9335	0.13492	14.6	15.2	15.6	16.7	17.4	18.9	20.9	22.1	24.6	25.8	28.4
13: 3	159	-1.2970	18.9991	0.13514	14.6	15.3	15.6	16.7	17.4	19.0	20.9	22.2	24.7	25.9	28.5

2007 WHO Reference

III ABBREVATION

AAP	American Academy of Paediatrics
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CDC	Centre For Diseases Control

CI	Confidence Interval
IAP	Indian Academy of Paediatrics
ICH & HC	Institute of child Health & Hospital for Children
IOTF	International Obesity Task Force
MAP	Moderate Physical Activity
NAFLD	Non Alcoholic Fatty Liver Disease
NCD	Non Communicable Disease
OGTT	Oral Glucose Tolerance Test
QOL	Quality of life
SD	Standard Deviation
TV	Television
WHO	World Health Organisation